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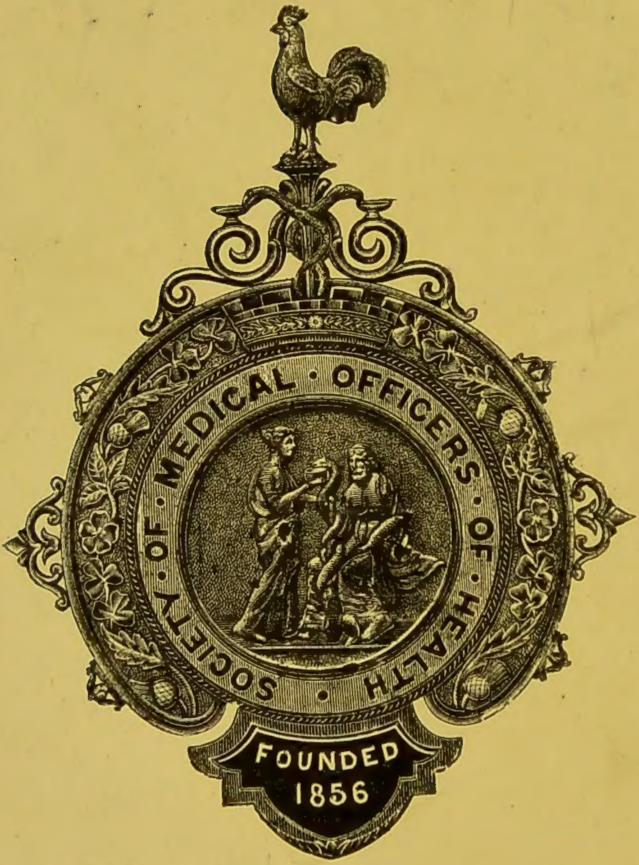
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SANITATION IN INDIA

BY

J. A. TURNER, M.D., D.P.H.,
Executive Health Officer, Bombay Municipality.

WITH CONTRIBUTIONS BY

B. K. GOLDSMITH,
M.B., D.P.H.,

S. C. HORMUSJI,
L.R.C.P., M.R.C.S., M.D., D.P.H.,

K. B. SHROFF,
L. M. AND S., D.P.H., D.T.M.,

AND

L. GODINHO,
L. M. AND S., M.D., D.P.H.

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LONDON SCHOOL OF HYGIENE & TROPICAL MEDICINE

DEDICATED

TO

THE MUNICIPAL CORPORATION

OF

THE CITY OF BOMBAY,

In acknowledgment of the assistance given by that
Body to the Public Health Department and the
Bombay Sanitary Association towards
promoting the education of the
people in Sanitation and
Public Health.

PREFACE

DURING the past twelve years the Public Health Department of Bombay has, under the auspices of the Government of Bombay, been giving a six months' course of lectures with a view to making provision for a supply of men versed in the theory and practice of sanitation, for employment as Inspectors or Health Officers in mofussil Municipalities. Students come from all parts of India and Burma. At the end of the course an examination is held and certificates are awarded to successful students. Latterly the Royal Sanitary Institute, London, offered to co-operate in the examination and grant its certificates to successful candidates. The offer was accepted and this arrangement has been in force since 1910.

With a view to improve the sanitary condition of the country and secure the better observance of health regulations, the Government of India and the Provincial Governments have recently put in force a scheme for the improvement of the sanitary services and laid down rules for the guidance and instruction of students.

The lectures and demonstrations given to students of the Sanitary Surveyors' Class by the Officers of the Public Health Department, Bombay, have now been elaborated and published in the hope that they may reach a wider circle of students than can manage to attend the Class and generally provide for Municipalities and others interested in questions of public health and hygiene a handy and practical guide to sanitation in India.

The book aims at providing the sanitary student with information on the practical application of modern sanitary methods adapted to India as well as to other places ; for the principles of sanitation are the same in all countries although the conditions may differ.

As far as possible, each subject has been dealt with in a practical form, so that the book may furnish information which may be of value to the sanitary student in carrying out the duties of a responsible post.

It will be seen that the Public Health Acts and Bye-laws both in England and India have been given in full on each subject, because we lay great stress on the value of properly constructed laws and regulations for any scheme of sanitary progress in India. As pointed out in the Chapter on Administration, the Acts and Bye-laws in force in the various towns of India are based on the Public Health Act, 1875, and other English Acts, modified to suit the conditions but are weak in many respects. The Sanitary Officer should realise the importance of a thorough acquaintance with the sanitary regulations in force in his district and be able to suggest amendments which are required from time to time.

We recognise that there is in the book much that relates to purely local sanitary methods of a large city like Bombay, but we make no excuse for this, for we hold that the highest standard should always be aimed at. All the towns and cities cannot work up to that standard at once. But though some towns and districts can only spend thousands while others spend lakhs, the principle involved is the same.

We do not claim to have covered the whole area of sanitation in India which is a very wide one, but we trust we have introduced some new matter not touched upon before. For contributions on some of the subjects the works of other authorities have been freely consulted. In the Chapter on Malaria the works of Manson, Ross, James, Liston and Bentley have been freely drawn upon, while it also includes a detailed statement of a Malaria campaign in a large city. Maxwell's book on "Refuse Disposal in England," Robertson and Porter's "Sanitary Law and Practice in England" are among other standard works to which we have referred.

A special feature of the book is the insertion of a large number of photographs illustrative as far as possible of the sanitary methods dealt with.

Though some of the measures advocated cannot be immediately applied to all parts of India, it is hoped that the example set by the larger cities, which are enumerated in the book, will have the effect of stimulating interest in sanitary matters throughout India, and that many of the growing towns and cities will gradually recognise the importance of organising a trained staff of Sanitary Officials and of carrying out those measures which experience has shown to be both necessary and practicable.

I am deeply grateful to my assistants and staff generally for their valuable co-operation and help;to Mr. N. S. Kowshik, the Chief Clerk of the Health Department, are due our warmest thanks for his assistance in correcting the proofs and to Mr. Shamrao G. Rajapurkar for many of the drawings. The co-operation of the *Times of India* Press has greatly facilitated the publication of this book.

BOMBAY.
January, 1914.

J. A. TURNER, M.D., D.P.H.

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SANITATION IN INDIA.

CHAPTER I.

ADMINISTRATION OF PUBLIC HEALTH ACTS IN INDIA.

THE Acts and Bye-laws, which regulate and control Public Health in different parts of the world, vary with the progressive tendency of the people.

In England the Public Health Act, 1875, forms the basis of all laws regulating and dealing with the control of Public Health and these laws are extended or curtailed to meet the requirements of any particular locality.

The English Public Health Acts apply to urban and rural districts and some are adoptive, but it is the tendency of every urban and rural district to adopt all those sections relating to Public Health.

The laws controlling Public Health in India are administered by the Municipality and comprise the Bombay Municipal Act and Bye-laws, and the District Municipal Act and Bye-laws, the Calcutta Municipal Act and Bye-laws, the Madras Municipal Act and Bye-laws. There are also the Cantonment Municipal Acts and the Municipal Act of Native States, where municipalities exist.

These Acts are very different in many respects, especially those sections dealing with Buildings, Housing, Overcrowding, Registration of Births and Deaths, Nuisances, Disposal of the Dead and Control of Infectious Diseases.

In large cities and towns in India, the executive control is vested in the officer appointed by Government. In Bombay he is called the Municipal Commissioner; in Calcutta, Chairman of Commissioners; in Madras, President; and in other Towns, Chief Municipal Officer; in the Districts, the Collector.

The sections of the Act read thus :—

The Commissioner, The Chairman, The President, The Collector, The Chief Officer,	may—or it is the duty of the—or the C. shall take measures for securing, &c., when it appears to the C., &c.

Certain sections of these Acts make it incumbent on the Executive Officer to obtain the sanction of the Standing Committee of the Corporation, or Commissioners, or the Council.

The Public Health Acts in British India, therefore, vary in degree according to the character of the district, urban or rural, and are amended and added to from time to time.

They are based on the English Public Health Act, 1875, and other English Acts ; the Municipal Executive Officer—Commissioner, Chairman, President, or Collector—taking the place of the Sanitary Authority in the English Act.

Under certain sections of the various Indian Municipal Acts, the Local Authority has power to make Bye-laws.

In the larger cities in the Presidencies of Bombay, Calcutta and Madras, the Executive Health Officer and the Executive Engineer are appointed by the Municipalities subject to the approval of Government, and the subordinate staff by the Commissioner, or the Municipality. The staff varies according to the size and importance of the city.

SANITARY ADMINISTRATION.

The Public Health Administration in England is controlled first, by the Local Government Board, a Department of Government ; secondly, by County Councils who appoint a County Medical Officer of Health ; thirdly, by the Urban and Rural District Council ; fourthly, by the Parish Council. In many counties of England, there is a County Medical Officer of Health, and in addition there are combined districts comprising Urban and Rural areas, which also appoint a whole-time Medical Officer of Health for the combined district, and there are also Medical Officers of Health for smaller towns and rural districts. All these officers are appointed by the various local Authorities subject to the sanction of the Local Government Board, and in the majority of cases, are whole-time men and half their salary is paid by the County Council out of the County rates.

The Local Authority administers the various Acts concerned with the Public Health, *viz.*, the Public Health Act, 1875, and the Public Health Act, 1890; the Rivers Pollution Prevention Act, the Factory and Workshops Act; Housing of the Working Classes Acts, Infectious Diseases Prevention Act, the Sale of Food and Drugs Act, the Margarine Act, the Dairies, Cowsheds and Milk-shops Orders, Canal Boats Act, Infant Life Protection Act, &c.

In large cities of England the Local Authority is the Corporation, which is divided up into Committees for different Departments,—Health Committee, Cleansing Committee, Lighting Committee, Streets and Buildings Committee, &c.

In London the County Council is the Local Authority, but for Public Health Administration the City is divided into 42 Metropolitan Boroughs, and the City and Port of London, each having its own Medical Officer of Health, Engineer, &c.

The Local Government Board is the Supreme Authority and can insist on the proper administration of the Acts by the Local Authority.

In India the sanitary administration of many large cities is carried on by a municipality with a Chairman, Commissioner or President, appointed by Government.

In Bombay the Local Authority is the Corporation, with a Commissioner appointed by Government. The Municipality of Bombay is the controlling body, and is comprised of a Corporation of 72 Members, partly nominated by Government, partly elected by rate-payers, and the Bench of Justices of the Peace, the Chamber of Commerce and the University, the Port Trust and the Improvement Trust.

In Calcutta this Authority is called Commissioners, with a Chairman appointed by Government, and the Commissioners are elected, as in Bombay, by ratepayers and nominated by Government, and elected by Justices, Chamber of Commerce, &c.

The Local Government is the Supreme Authority and can insist on the proper administration of the Acts.

The Executive in Bombay consists of the Municipal Commissioner appointed by Government.

The Executive Health Officer is appointed by the Corporation, subject to the approval of Government.

The Executive Engineer is also appointed by the Corporation, subject to the approval of Government.

In Madras the Local Authority is Commissioners with a Chairman appointed by Government and the Health Officer, generally a Member of the I. M. S.—appointed by Government—now appointed by the Corporation.

In the other towns, Cawnpore, Ahmedabad, .Poona, Surat, Delhi, Lahore, Lucknow, Agra, Nagpur, &c., &c., the Local Authority is the Municipality.

The Government Sanitary Service in India consists of a Sanitary Commissioner to the Government of India and to the Local Government, and Deputy Sanitary Commissioners with the Local Government. Their duties are chiefly concerned with vaccination, but they advise generally on questions in connection with the public health of the mofussil municipalities and districts.

The Government of India have within the past twelve months decided to improve and strengthen the Sanitary Service, and the following is the Resolution dealing with Sanitation in India :—

No. 921—36, dated Simla, the 23rd May 1912.

RESOLUTION.—By the Government of India, Department of Education, (Sanitary).

"The Government of India have had for some time under their consideration the question of the improvement and strengthening of the sanitary services in India. The Plague Commission in 1901 strongly urged the necessity for the improvement in certain directions of the organization of the Sanitary Department in India, with the object of dealing more effectively with outbreaks of plague and other epidemics and with the general sanitation of India. In 1905 a scheme was formulated by the Royal College of Physicians for the creation of a medical and sanitary organisation in India, and the inadequacy of the sanitary services, as then constituted, was again emphasised.

In 1907 the Government of India addressed all local Governments inviting them to consider certain proposals for reform. The views of local Governments have been considered in detail, and a scheme has now been formulated which has received the sanction of the Secretary of State. The object of this Resolution is to indicate for general information the lines on which it is proposed that re-organisation should proceed.

2. The administrative machinery of the Sanitary Department is already in most respects fairly complete and efficient, The improvements that the Government of India desire to effect are in the direction of further decentralisation of control; of widening the field of recruitment by throwing open the higher posts to fully qualified Indians of proved aptitude; of strengthening the staff in some provinces in which at present it is admittedly inadequate.

3. Hitherto the appointment of Sanitary Commissioner in all provinces, with the exception of Madras and Bombay, has rested with the Imperial Government. The Government of India have now authorized all local Governments to select their Sanitary Commissioners from officers serving in the Provincial Sanitary Department, provided that no officer of less than fifteen years' service be appointed without their previous sanction. They will also retain the selection in their own hands when no suitable officer is available in the province, or when the local Government desires to appoint an officer serving in another province. The Government of India further do not consider it desirable that there should be any limitation to the tenure of the office of Provincial Sanitary Commissioners and the existing orders on the subject contained in the Home Department Resolution No. 4-340-51, dated the 7th June 1888, are cancelled.

4. It has become evident that the existing number of Deputy Sanitary Commissioners in more than one province is inadequate in view of the exacting nature of the duties

which they have to perform, and the unwieldy size of their charges. The area served by these officers ranges from 129,241 square miles in Madras to 24,597 square miles in Bombay, and the population from 36½ millions in Madras to 3½ millions in Bombay. The Government of India have now decided to create eight additional appointments of this class, two each in the three provinces of Madras, Bengal and the United Provinces and two which were originally proposed for Eastern Bengal and Assam. The allotment of these posts, with those sanctioned for Bengal, will require re-adjustment in view of the recent administrative changes.

The appointments of Deputy Sanitary Commissioners will no longer be reserved for officers of the Indian Medical Service and Indians possessing the necessary qualifications will be eligible for these posts. The selection of candidates for Deputy Sanitary Commissionerships, whether officers of the Indian Medical Service or not, will remain with local Governments, subject to the following conditions :—

(1) that the candidate holds a British diploma in public health and a registrable medical qualification ;

(2) that no officer is appointed who is not an accepted candidate for the Sanitary Department ; and

(3) that the Government of India asked for an officer when the local Government has no candidate available who is qualified and on its accepted list of candidates.

5. The Government of India consider that the terms to be offered to Deputy Sanitary Commissioners, not belonging to the Indian Medical Service, should be non-pensionable, but that the scale of pay should consequently be fixed at rather more than two-thirds of the pay of Indian Medical Service officers in the department. The scale which they have determined is as follows :—

Years of service.	Rs.
1-2 (probationary)	500
3-5	600
6-10	700
11-15	800
16 and over	900

For approved service of over 20 years, pay of Rs. 1,000 will be given up to 25 years which will ordinarily be the limit of service. Officers appointed on this scale will be eligible for leave under the Indian Service Leave Rules. First appointments will be made on probation for a period of not less than two years, and no officer will receive any increment of pay during the probationary period of his service; but in the case of men who have rendered approved service as municipal officers of health, the period of probation may be dispensed with at the discretion of local Governments and the full rate of pay (*viz.*, Rs. 600) allowed. All Deputy Sanitary Commissioners will be debarred from private practice.

6. Another part of the administrative machinery which has attained a position of varying usefulness in different provinces is the Sanitary Board. These Boards are beneficial in emphasizing the importance of the subject of sanitation, in correlating sanitary schemes with administrative exigencies, and in securing direct discussion between sanitary experts and those who can appreciate and represent the attitude of the general population. The constitution of these Boards should, the Government of India consider, be determined by the local Government with reference to the functions with which they are to be entrusted. If the Board is purely an advisory body, it should contain the smallest number of persons sufficient to ensure that projects submitted to it will be examined adequately from the points of view of public health, of engineering and of finance and general administration. If the Board has specific powers of sanction, and is, within certain limits, practically to represent the local Government in matters of sanitation, it will appropriately be larger; but it cannot, in the Government of India's opinion, be desirable that a large body of officials without power to sanction schemes should be interposed between the local authorities and the provincial Government.

7. The weakness of the executive establishment of the service, and the inadequacy of the staff of trained officers of health, is a defect which has been prominently brought to

the notice of the Government of India, the remedy for which is a necessary preliminary to any substantial improvement of sanitation. The Presidency towns and a few of the larger cities have such officers ; but as a rule the Civil Surgeon is the only health officer of the towns in a district. It is difficult for him to give sufficient attention to the sanitary requirements of the head-quarters town ; it is impossible for him to make more than an occasional inspection of other towns. The scheme now sanctioned provides for the appointment of health officers of the first class for larger municipalities and of the second class for the smaller towns, in accordance with detailed proposals received from the local Governments. A health officer of the first class will be required to have a registrable medical qualification and a British diploma in public health. The necessity for a British diploma will however be only temporary as the Government of India trust that it may be possible to remove the second restriction so soon as arrangements can be made in India which will enable Indians trained in this country to become health officers of the first class. For health officers of the second class the main qualifications will be a good general education, supplemented by a course of training in public health approved by the local Government. A salary of Rs. 300-20-500 is considered suitable for officers of the first class (with higher pay in exceptional cases) and of Rs. 150-10-300 for officers of the second class. The Government of India leave it to local Governments to determine in the case of both classes, whether a provincial service should be constituted or whether the appointments should be local ; but they consider that grants-in-aid by local Governments should be made only on conditions which will ensure that qualified men are appointed, and that they will have reasonable security of tenure. They also consider that the necessary power should be vested in local Governments to require a municipality to appoint a health officer and to veto the appointment of an unfit person.

In order to assist local Governments to establish this trained service, the Government of India have offered to grant an annual subsidy to those Governments which cannot find the money from provincial funds, to the extent of the entire cost of the additional Deputy Sanitary Commissioners (calculated at the rates proposed for men not belonging to the Indian Medical Service) *plus* half the cost of the municipal health officers in the towns in which local Governments consider they should be appointed. It is hoped that the balance can then be found by the municipalities and local Governments concerned.

8. The subordinate supervising staff of the conservancy establishment also calls for improvement. In most towns there is an official whose functions resemble those performed by an inspector of nuisances in England. It is however exceptional to find in this position a man who has any technical knowledge of his work. The Government of India think it desirable that a service of trained sanitary inspectors should be organized in municipalities, based on such standard of population, income or area as commends itself to the local Governments. They have recommended to the notice of the other provinces the system in force in Madras, whereby every municipality is required to employ at least one trained inspector, a second inspector if the population exceeds 30,000 and three inspectors if the population exceeds 50,000 ; but they leave it to local Governments to determine the preliminary qualifications to be required from candidates, the course of training they must undergo and the rates of pay to be given. They trust that local Governments will be able to give assistance to such municipal bodies as require it in the organization of this subordinate staff.

9. The Government of India are confident that the schemes now sanctioned will mark a substantial advance towards the organization of a trained sanitary staff capable of further expansion in the future, and that it will prove an efficient agency for extending a knowledge of elementary hygiene among the people."

Towns in India, in which any attempt at sanitary administration is made, vary in population from 50,000 to 1,000,000. In the majority of the smaller towns, the duties of the Health Department, if one exists, are very ill-defined and perfunctorily carried out. But no actual hard and fast rules can be laid down—much depending on the rateable value, the commercial enterprise and importance as a residential centre, the class of inhabitants, the climatic conditions and facilities for communication.

In view of the desire of the Government of India to improve the sanitary administration of the Empire, certain principles may be laid down with regard to the following :—

1. Water-supply.
2. Drainage and Sewage disposal.
3. Refuse collection and disposal.
4. Registration of Births and Deaths.
5. Control of Infectious Diseases.
6. Supervision and Control of Trades and Factories.
7. Condition of Houses, their improvements.
8. Re-arrangement of crowded areas and Town-planning.
9. Medical Relief, Malaria, Tuberculosis.
10. Disposal of the Dead.
11. Pollution of Rivers and Wells.

On taking over charge of a town, or district, the Health Officer should first obtain an accurate map giving the area, number of inhabited houses, streets, lanes and oarts, and the population of each section. He should divide the district into sections and put each section under a Sanitary Inspector, who should be an educated and trained man.

A Health Officer should be appointed either in a town or combined district with 100,000 persons or more. He should be a qualified medical man with experience in public health work.

He should have a staff of Conservancy and Sanitary Inspectors—one to each 20,000 population.

For the registration of births and deaths, there should be two Registration Offices, with Branch Offices if the district is a combined one.

These Officers should be qualified medical men, or Sub-Assistant Surgeons, with training in sanitation.

The labour staff will depend on the particular industry or occupation.

Details of every street and house should be available and a house-to-house inspection made by the Sanitary Inspectors and the method of drainage, night-soil disposal and refuse collection and disposal laid down.

In every town or district of any size, a large number of huts or small houses exist occupied by the poorest classes.

It is not to be expected that modern sanitary methods which are adopted in large cities can be applied here, but some attempt can be made to improve their surroundings.

In the majority of these districts, it will be many years before the inhabitants can be taught the value of cleanliness in and around the dwellings; nor will it be possible to drain any sullage water and night-soil or adopt other than existing methods, but there are many ways of improving the sanitation of a district besides expensive drainage schemes.

Land is plentiful and labour is cheap and the climate is favourable for disinfection by the sun and wind.

These conditions should be taken advantage of, for even the poorest class of huts can be improved by regulating their position and putting a mukadam in charge who can supervise the cleaning of the surroundings, disposal of night-soil, filling in of damp places and keeping a register of births, deaths and sickness.

BOMBAY.

Bombay may be taken as an example of a large city in India where modern sanitary methods are applied.

The population of Bombay is about 1,000,000 and in point of number it is the second city in the Empire.

Name of City.	Population.	Area.
Bombay	979,445	14,575 acres.
Calcutta	890,000	20,547 ,,
Madras	500,000	17,280 ,,
Manchester	714,427	21,600 ,,
Liverpool	746,566	19,500 ,,
Glasgow	784,455	12,975 ,,

Name of City.	*Rateable Value.*	*Annual Expenditure, Cleansing Department.*
	£	£
Bombay	3,300,000	113,000
Calcutta	2,500,000	78,000
Madras	94,933	23,000
Manchester	4,554,958	242,000
Liverpool	4,783,000	120,000
Glasgow	5,960,000	130,000

The Head of the Health Department is the Executive Health Officer.

For administration purposes, the City has been divided into seven wards, each under the subordinate charge of a Deputy Health Officer, who is responsible both for the conservancy and sanitary work of his ward. The Deputy Health Officers are assisted by a Superintendent of Conservancy and a staff of Sanitary and Conservancy Inspectors, Assistant and Sub-Inspectors. The Deputy Health Officers are under the control and work under the general orders of the Executive Health Officer, who is assisted by two Assistants.

REGISTRATION OF BIRTHS AND DEATHS.

For the purposes of the registration of births and deaths and free medical relief, the City has been divided into ten districts with ten charitable Municipal Dispensaries—each in charge of a Registrar, having under him two Sub-Registrars and one trained visiting Nurse and Midwife. Each of these District Medical Officers is equipped with staff for registering births and deaths, for enquiring into the cause of death, for checking cemetery returns and for disinfecting houses and rooms where cases of infectious diseases may have occurred or dead rats may have been discovered and reported. The work of the Registrars is supervised by the Deputy Health Officers and the Executive Health Officer with his two Assistants.

There is also a Special Assistant Health Officer in charge of the Arthur Road Hospital for infectious diseases and the Maratha Hospital for Plague

MUNICIPAL LABORATORY.

For analytical and bacteriological examination there is a Municipal Analyst in charge of a fully equipped chemical and bacteriological Laboratory ; chemical analysis and bacteriological examination of municipal waters is conducted by him.

The Veterinary Staff includes four qualified Veterinary Surgeons with a Shalotri, who inspect the Milch-cattle Stables in the City and the Municipal bullocks, and are in charge of the Municipal Bullock Hospital.

The Vaccination Staff includes, besides the Superintendent and the Assistant Superintendent, ten Vaccinators, one Head Clerk, with four subordinate clerks and the menial staff.

There is also a Special Malaria Officer who has a separate Staff.

The Conservancy and Sanitary staff, exclusive of the labour staff, consists of—

1	Superintendent of Conservancy.
2	Chief Inspectors.
7	Sanitary Inspectors.
7	Conservancy Inspectors.
1	Loading Siding Inspector.
6	House Drain Inspectors.
7	Assistant Inspectors.
68	Sub-Inspectors.
1	Halalkhor Inspector.
5	,, Sub-Inspectors.

DUTIES OF THE STAFF.

The duties of the staff are on the same lines as those in English cities, but are of a more multifarious and exacting character. The habits of the people, their caste prejudice and religious susceptibilities and the difficulties of enforcing the Acts and Bye-laws, and the contrcl of a large staff of labourers render the work of the Health Official much more arduous and the Health Officer must be as much a teacher as an Executive Officer; and, while exercising tact and discretion, must possess a firm guiding hand both with regard to the people and the authorities under whom he serves.

The Executive Health Officer is, under the Municipal Commissioner, the Chief Supervising Officer.

DEPUTY HEALTH OFFICERS.

The Deputy Health Officer is the Health Officer of a Ward which has a population of 85,000 to 250,000.

The duties of the Deputy Health Officer are—

(1) to inform himself, as far as practicable, respecting all influences affecting or threatening to affect injuriously the public health in his Ward;

(2) to enquire into and ascertain the causes, origin or distribution of diseases within his Ward, and to ascertain to what extent the same has depended on conditions capable of removal or mitigation;

(3) by systematic and daily inspection in his Ward to keep himself informed of the conditions existing therein and injurious to health; submit reports to the Health Officer on outbreaks of infectious disease or special mortality occurring in any house or section; report to the Health Officer on any matters likely to affect the health of the City generally, and on any matters which should be brought to his notice;

(4) to exercise full administrative control over his Ward. and to carry out the sanitary provisions of the Municipal Act;

(5) to supervise the work of the Inspectors and Sub-Inspectors, and to see that the conservancy of the Ward is efficiently carried out;

(6) to supervise the work of the District Registrars and their Dispensaries and offices, to enquire into any outbreak of infectious disease reported by the District Registrar, to arrange and supervise removal of the suffering to hospital,

disinfection and other measures necessary for dealing with such cases of infectious disease ;

(7) to supervise the carrying out of all special Plague measures, such as disinfection, evacuation of infected houses, removal of cases to hospital and contacts to health camps, and supervision of health camps in his Ward ;

(8) to enquire into complaints made by the public, to make reports, when required, to the Health Officer and the Municipal Commissioner ;

(9) to serve notice on owners of premises in which there are sanitary defects and to conduct prosecutions in the Police Court against offenders of sanitary provisions of the Municipal Act ;

(10) to carry out all orders and instructions of the Municipal Commissioner and the Health Officer.

The staff of a Ward consists of a Deputy Health Officer, his office staff and outdoor staff of District Registrars, Sub-Registrars, Visiting Nurse and Midwife, Birth registering Karkoons, Sanitary and Conservancy Inspectors, Sub-Inspectors, Mukadams and labour staff of begaris, cart-drivers and halalkhors ; and cemetery clerks who are in charge of cemeteries and burning ghats.

Outdoor Staff.—Each registration District is in charge of a District Registrar, who is a qualified medical man, having under him 2 Sub-Registrars, who are Hospital Assistants, a Visiting Nurse and Midwife, birth and death registration Karkoons, disinfecting gangs in charge of an Inspector and ambulance coolies.

Sanitary Staff.—There are a Sanitary Inspector and 2 Assistant Sanitary Inspectors in each Ward.

Conservancy Staff.—There is a Conservancy Inspector in charge of each Ward with a Sub-Inspector in charge of each section. In each Ward there is a gully-flushing engine and gang in charge of a Sub-Inspector.

The labour staff is directly controlled by Mukadams.

It consists of begaris to sweep the roads and footpaths and house gullies ;

Cart fillers to fill the cutchra carts and cart-drivers for the carts ;

Gully plungermen to clean gully traps ;

Halalkhors to clean privies and remove night-soil to depôts ;

Vacant ground cleaners to remove night-soil from vacant ground, street corners, &c.;

Public latrine and urinal cleaners.

In each Ward there is a drain cleaning Inspector with 2 Sub-Inspectors, masons and staff of drain cleaning begaris. This staff clean house-drains, repair broken house-drains and gully traps, sending in bills to the house-owners concerned. They also clean waste-water pipes and all connections to house-drains.

The routine work of a Deputy Health Officer consists of a visit to his Ward stables and Dispensary and inspection of some part or parts of his Ward in the early mornings between 6 and 10 A.M. and from 11 to 5 P.M. or later, during which hours office work and outdoor supervision work is carried on. It includes also the following :—

Special inspections in the afternoons or evenings, and attendance at muster early morning and during the day at the Ward stable at least once a week. Surprise visits to the stables at least twice a week to inspect the feeding of bullocks.

Inspections in the mornings including supervision of the work of the labour staff, *i.e.*, cleaning of roads, gullies, gully traps, house-drains, waste-water pipes, privies, flushing engines and reels of hose attached to stand-pipes, condition of public latrines and urinals, dust bins and removal of refuse and all the conservancy work of the City.

Visits to places or premises for enquiry into complaints made by the public, which cannot be dealt with by the Sanitary Inspectors, or for reports to be made to the Municipal Commissioner or Executive Health Officer.

Inspection of sites or premises for which building plans have been submitted and which require special inspection.

Inspection of premises in which the privy accommodation is insufficient or for sanitary reasons objectionable with a view to action being taken under sections 248 and 249.

Examination of wells, tanks, fountains, basins and other collections of water for presence of larvæ of anopheles mosquitoes, or for cleaning, covering, filling in, &c., under section 381.

Inspection of premises, for which notices for limewashing and sanitary improvements under sections 257, 375 and 377 have been served, to see if the work has been satisfactorily carried out.

Inspection of licensed stables with special reference to the carrying out of the requirements of the bye-laws, the prevention of overcrowding, daily removal of dung and litter; and in case of milch-cattle stables, for prosecutions for feeding cows and buffaloes, &c., on stable litter under section 384, clause (*c*).

Inspection of houses, where cases of Plague or other infectious disease have occurred or which are insanitary, for reports to be made to the Executive Engineer for action under the Epidemic Diseases Act to be taken for their improvement.

Inspection of hotels, restaurants, eating houses, tea shops, dairies and bakeries.

Inspection of places, where refuse is thrown into the gullies and streets, for prosecution under section 372, clauses (*a*), (*e*) and (*f*).

Inspection of food exposed for sale and the seizing of same, if necessary, under sections 413 to 417A.

Collection of samples of milk, butter, foods, drinks, drugs for forwarding them to the Municipal Analyst for analysis.

Inspection of ghee exposed for sale and collection of sample, if necessary, for analysis and action under the special Ghee Act.

Inspection of public latrines and urinals to see if the same are in good repair and proper working order and are being kept in a cleanly state.

Selection of sites where new public latrines and urinals are required and reporting the same to the Health Officer.

Inspection of Health Department carts and bullocks and chawls occupied by begaris and halalkhors.

Inspection of factories, &c., for smoke nuisance and action under section 391.

Inspection of District Offices and Municipal Dispensaries, visiting houses where cases of infectious diseases have occurred, making inquiries in the origin of infection, supervising disinfection, persuading relatives to remove cases to the hospital for infectious diseases, supervision of Plague measures and supervision of health camps.

Supervision of the work of the Nurses, birth karkoons and death registration ramosis.

Surprise visits to the various night-soil depôts in the Ward and inspection of the register kept by the tripmarker.

Inspection of the work of cleaning house drains and replacing broken gully traps, drain pipes, &c.

Special inspection of premises about which action is being taken in the Police Courts.

Visiting premises for reporting to the Municipal Com missioner if licenses for stables or firewood depôts should be granted or permits issued for proposed employment of engines at premises.

Inspections on above lines are made in the early mornings and afternoons.

The office work of each Deputy Health Officer includes the writing of reports to the Municipal Commissioner and the Executive Health Officer; to the Executive Engineer, Drainage Engineer and Water Engineer for action required to be taken by their Departments; to the Superintendent of Licenses informing him of the infringement of the terms of their licenses by licensees of stables and other licensed premises;

Drafting and signing letters in reply to complaints or requiring house-owners to carry out certain works.

The examination and disposal of building plans.

The preparation of pay abstracts of all the supervising and labour staff.

Disposal of defaulter sheets and reports, by the District Registrars and Inspectors, of offences committed daily and infliction of fines or other punishments.

Attending the Police Court every week to conduct cases.

Inspecting or dealing with any urgent nuisances reported by the Sanitary Inspector of the Ward, who attends every day for the purpose at the office of the Deputy Health Officer.

Submitting and receipting bills for works carried out by the Health Department for private persons, such as cleaning, repairing of house drains and their connections, sweeping certain private roads and compounds and removing refuse.

Reporting to the Executive Engineer, Drainage Engineer and Water Engineer defects in public latrines, stables, chawls and other buildings belonging to the Municipality which are in the charge of the Health Department and certifying the bills for the necessary works carried out.

Sending in indents for the feed of Health Department bullocks, for brooms, baskets, lime and other articles required by the Health Department for the use of the Ward.

Arranging for the removal of refuse and night-soil from military camps, circuses, private camps, &c.

Arranging for the supply of special and ordinary halalkhor service to private houses, hotels, factories, camps, &c., and calculating the taxes leviable for such special halalkhor service on observations taken of the amount of night-soil and cesspool water removed.

DISTRICT STAFF.

For the purposes of medical relief, registration of births and deaths, and taking measures against infectious diseases, the City of Bombay is divided into 10 parts, called Districts, and each District is in charge of a fully qualified Medical

Officer, called the District Registrar, who has under him the following staff :—

1. Two or more qualified Hospital Assistants, or Sub-Assistant Surgeons, one for each section, called the Sub-Registrar, whose duty is to check immediately all death reports received from cemeteries or death ramosis, to make house-to-house inspection and find out sickness and births, to treat poor patients at their houses, to supervise disinfection, to report to the District Registrar sanitary defects observed in houses, to check the work of birth karkoons and to assist the District Registrar generally. He has to reside in his own section, and in the Dispensary of the District if there is accommodation.

2. One fully qualified midwife, called the Nurse, whose duty is to make house-to-house inquiry, so as to instruct the female population as regards feeding of infants, domestic and personal hygiene, and other sanitary matters, to conduct delivery cases in poor families, and to find out births.

3. Three or more birth karkoons, one for each section, whose duty is to make house-to-house inspection, find out births and sickness, and to serve vaccination notices.

4. Cemetery karkoons in charge of each cemetery. In large cemeteries there are fully qualified Hospital Assistants. Their duty is to register deaths at the cemeteries and to ascertain the cause of death from the relatives of the funeral party.

5. Death registration ramosis, six or more for each District. Their duty is to attend day and night at the prominent corners of the City, and to give a pass to the funeral party after personally ascertaining the proper address of the deceased. One of these death-passes is presented at the cemetery and the other is sent to the District Registrar of the District for immediate inquiry as to the cause of death.

6. A Disinfecting Sub-Inspector to carry out disinfecting operations.

7. Mukadams, a gang of coolies, camp master, clerks, peons, &c.

The District Registrar, who generally resides in his own District or close to it, is in charge of all sections of his District and is personally responsible for them. His duties are to attend both in the mornings and in the afternoons, the Municipal Charitable Dispensary which is situated in the central part of his District, to treat, at their own residence, poor patients who are unable to move out of their houses, to check death reports, to supervise the work of Sub-Registrars and birth karkoons, and the Nurse, to supervise the disinfection of infected houses, evacuate houses where necessary, to make special report to the Health Officer on the outbreak of any special diseases, to report to the Deputy Health Officer all insanitary houses and any sanitary defects observed during his rounds, and to assist the Deputy Health Officer and the Health Officer generally. He has also to look after the camps and take prompt measures to prevent the spread of sickness in them.

Each Dispensary is also the office of the District Registrar which is provided with a telephone connection to receive information of infectious diseases from the public. Special arrangement is made to receive messages at any time during the day and night. On the occurrence of cases of Plague, Cholera, Typhoid Fever, Relapsing Fever, Small-pox and Phthisis, disinfection of the infected clothes, etc., is carried out.

The rules for the guidance of the Outdoor staff are as follows :—

HOURS OF DUTY.

The hours of work on week days are from (*Bombay time*) 5-30 to 10 a. m. and 1-30 to 5-30 p. m. ; on Sundays from 5-30 to 10-30 a. m.

The following are the hours of muster for all the Ward staff except halalkhors :—(1). *At Stables* :—Muster is taken by the Ward Clerk in the presence of the Inspector or in his absence in the presence of the senior Sub-Inspector at 5-30 a. m. and 1-30 p. m. and 5-30 p. m. (2).—*Outside Stables* :—In sections, by the section mukadams in the presence of the section Sub-Inspectors at 10 a. m. (3).—*At*

Night-soil Depôts :—At such hours as may be fixed, considering the position of the depôt and work of the locality, in the presence of the trip-marker on duty and the section halalkhor mukadams.

Halalkhor mukadams must also attend the 1-30 p. m. and 5-30 p. m. musters at stables and present to the Ward Clerk, at the 5-30 p. m. muster, a report of the inspections made by them during the day.

THE SUPERINTENDENT OF CONSERVANCY.

(1). The Superintendent shall supervise the working of the cleansing department of the City, including road cleaning, refuse collection and removal and collection and disposal of night-soil and the working of steam motors.

(2). He will work directly under the Executive Health Officer and shall report *weekly*, or, oftener if necessary, through the Assistants to Health Officer.

(3). His weekly reports should include the result of his systematic inspection of the cleansing of each Ward as well as surprise visits to all depôts and house gullies.

(4): The Deputy Health Officers are still responsible for the cleansing of their Wards and the supervision of their staff. The Superintendent's duties will in no way interfere or clash with those of the Deputy Health Officers, unless he finds the work is not being properly done.

CHIEF CONSERVANCY INSPECTORS.

The Chief Inspectors shall supervise the working of the Conservancy staff of the Wards to which they are appointed.

2. They shall attend the morning and afternoon musters of their Wards by turns and report any irregularity observed to the respective Deputy Health Officers.

3. They shall look to the removal of cutchra, to bullocks, carts, etc., and see that the work is properly done.

4. They shall send to the respective Deputy Health Officers every week samples of grain, supplied by the Contractor, giving their opinion on the same.

5. They shall attend the Office of the Deputy Health Officer once or twice a week as directed and report to him the result of their inspections.

6. They shall carry out any orders given to them either by the Deputy Health Officer, Assistants to the Health Officer or the Health Officer, and submit all reports, etc., to the Deputy Health Officer, and to the Health Officer or the Assistant to the Health Officer through their respective Deputy Health Officers.

7. They shall keep a record of their work in a diary which should be sent every week to the Senior Deputy Health Officer of the Ward where they work.

CONSERVANCY INSPECTORS.

1. It is the duty of an Inspector on taking charge of a Ward to make himself acquainted with the boundaries and sections of the Ward, the distribution of the staff under his orders in each section of the Ward, the places of special sanitary importance, latrines and cesspools, and to ascertain the history of all land and buildings belonging to the Municipality, particularly all land and buildings that may be in the charge of the Health Department.

2. The Inspector should regularly and systematically examine the accounts, registers, books and records in his Ward office, and is responsible for these being kept in proper order.

3. The Inspector should carefully examine all grass, grain and other articles supplied for the feeding of his Ward bullocks and all stores supplied for the working of the Ward, *at the time of receiving delivery,* and he must reject at once any article that is not of the standard quality or sample. Certain hours are fixed from time to time for the delivery of rations and stores at the different Wards, and the Inspector has to be present to take delivery from the Contractor or his agent, except in the event of being off-duty or engaged on any emergent duty, *e.g.* sewer cleaning, or in attendance on the Commissioner, Health Officer, or Deputy Health Officer ; in the absence of the Inspector, rations or stores of any kind are not to be taken "delivery" of by any of

the Ward staff other than the Sub-Inspector on feeding duty, and the Sub-Inspector should satisfy himself that the rations or stores are of the standard quality of sample, and show such rations or stores as he has taken "delivery" of to the Inspector on his return to the stable, and the Inspector has to make a report to office about the Sub-Inspector having done so.

4. It is the duty of the Inspector to inspect his Ward stable and compound not less than twice a day—once in the morning and once in the evening—to see that the stable and compound are thoroughly clean, that the stable floors, mangers and neck fastenings for the animals are in good order, and that all sick and other bullocks off work are properly attended to.

5. The Inspector should superintend from time to time the shoeing of the bullocks in his charge and satisfy himself that this important work is properly carried on.

6. The Inspector is responsible for the feeding of his bullocks and should personally see that the animals are properly and regularly fed in accordance with such orders as may be issued on the subject.

7. The Inspector is responsible for all carts, bullocks, and stores in his charge and must make good any loss or deficiency which may be caused through his neglect or want of care.

8. The Inspector shall each month, in consultation with the Veterinary Inspector, distribute weak bullocks so as to give them light work to the portions of Wards in which there is least work and submit each month a special report on this subject.

9. The Inspector shall inspect from time to time all carts in his charge, and send those found requiring repairs at once to the Municipal Workshops. The Inspector shall arrange a system for the regular cleaning of carts on such day and at such hour as may be found most convenient, and note the following points:—The carts are to be thoroughly scraped clean all over and, if necessary, washed. Each cart-driver and the

stable mukadam are responsible for the cleanliness of the carts. The most favourable time for cleaning carts and examining them will be Sunday forenoons.

10. The Inspector shall see that the proper quantity of rations for the feeding of the bullocks of his Ward is daily given out in accordance with the orders issued on the subject.

11. It is the duty of the Inspector to inspect certain portions of his Ward in the morning and afternoon, and to ascertain that the Ward staff are properly and intelligently carrying out their duties; to note, for necessary action, all nuisances which he may observe in or about streets, houses, gullies or other places; to examine house and sweepers' gullies, privies, latrines and urinals, and generally to take prompt action for the removal of nuisances and to enter a short detail of such morning and afternoon inspection in the Inspectors' morning report. As a rule, these inspections should be so arranged that every portion of the Ward is visited not less than once a week.

12. Any order which an Inspector may give in the execution of his duty is to be promptly obeyed by the Ward staff, and in the event of any one of them refusing to obey or carry out such orders, it is the duty of the Inspector to at once report the matter to the Deputy Health Officer. An Inspector is not to suspend any one of his staff except by order from the Commissioner, Health Officer, or Deputy Health Officer, except in the case of wilful disobedience of order or for drunkenness.

13. An Inspector should at once, in case of a number of men combining to strike work, send an immediate report of the same by a Sub-Inspector or mukadam to the Health Officer or Deputy Health Officer and in the meantime take such measures as he considers best to deal with the men threatening to strike work or refusing to perform duty.

14. It is the duty of an Inspector to make himself generally acquainted with the Municipal Act and Byelaws, and specially acquainted with such sections and

bye-laws as relate to public health and concern the Health Department.

15. It is the duty of an Inspector to personally instruct clearly and patiently his subordinates in the nature of their duties.

16. An Inspector must prevent, so far as lies in his power, the practice of smoking in stables by any Municipal servant, European or Indian, and he must also take all reasonable precautions to guard against fire, and see that buckets filled with water are hung up in convenient places all round the stable, and personally satisfy himself that the buckets are kept full and ready for use. An axe and saw should be kept in some convenient place, known to all, for use in case of a fire.

17. The Inspector should keep proper musters of his staff in the books provided for the purpose, and at the end keep a summary of the labour staff showing the number of absentees against each heading under each date. The books should be initialled daily by the Ward Inspector in token of the musters being correct. The punctual commencement of work by the labour staff is one of the most important objects which the Inspector must keep constantly in view.

18. In case of any of the labour staff going on 3 or 4 days' leave by providing their own substitutes, a separate book should be kept in each Ward for future reference showing against each date the names of the persons on leave and of their substitutes.

19. The following procedure should be adopted in sending samples of grain either to the Health Officer, Assistants to the Health Officer or Deputy Health Officer :—

(1). The grain should be sent without delay to the Office.

(2). The Inspector should give his opinion about the grain on the forwarding memo.

(3). Small quantities of grain should be taken from about 40% to 50% of the bags and collected in a bucket. These should be mixed properly and a sample from this should be sent to the Office. The bags from which the samples were taken should be marked in chalk for identification.

(4). The samples should be collected by the Inspector himself and not by any of his subordinates.

20. The Conservancy Inspector is responsible for the care of all night-soil depôts, public latrines and urinals under his charge.

21. He must make a daily round of inspection of as many depôts as he can visit, noting the time of his visit and the way the work is being carried out. He must initial the depôt slips with the time and date of visit.

22. He must pay several times during each month special visits to depôts before 5 a.m. in order to check the attendance of the Ward halalkhors and mukadams and report at once any neglect observed.

23. The Conservancy Inspector shall take a general muster of the labour staff at least three days before the end of each month with a view to ascertain the names of those persons who reside in Municipal chawls and also to intimate to the begaris and halalkhors any infliction of fines, the number of days they were absent, etc.

24. It is the duty of the Inspector to arrange for systematic rat campaigns in his Ward, to supply rat traps to those who require them and to arrange for the removal of such traps from the houses in which they were laid. He will also arrange to send rats caught and those sent to him by the public to the Bombay Bacteriological Laboratory for their examination and communicate the results of examination as to the rats being infected or otherwise to the parties who had sent rats. As soon as the Inspector becomes cognizant of the fact that infected rats have been found in a certain house, he will take steps to have the gullies flushed and pesterined.

25. The Conservancy Inspector will systematically examine all gullies, catchpits, inspection chambers, pools

of water, &c., &c., in his Ward and take steps to have them pesterined so as to destroy the breeding places of mosquitoes.

26. The Inspector should be present at musters.

27. The Inspector and Sub-Inspectors should know exactly how many men and women, carts, bullocks and street boys are assigned to each section.

28. A statement with a map of each Ward divided into sections and sub-sections with labour staff, carts—stationary and travelling—with depôts and sidings should be placed in a conspicuous place in the Ward stable office.

29. The Inspector shall attend the office of the Deputy Health Officer once a week or whenever required.

HOUSE DRAIN INSPECTORS.

1. The House Drain Inspector shall supervise the working of the House Drain staff under him.

2. In addition to the duties of the Conservancy Inspector as defined in rules Nos. 1, 2, 7, 11, 12, 13, 14, and 15, he shall attend to all chokes in gullies and drains and see to their removal.

3. He shall see that the House Drain notices are properly served and the work is properly done.

4. The House Drain Inspector is responsible for keeping a proper account of the materials, &c., used in each case and the number of labourers employed.

5. The House Drain Inspector shall submit every month to office bills in triplicate showing the expenditure incurred in each case.

6. The House Drain Inspector and his Sub-Inspectors shall recover all bills and in no case shall keep these outstanding for more than two months without bringing the fact to the notice of the Deputy Health Officer, giving full reasons in each case.

7. The House Drain Inspector shall be personally responsible for all House Drain work and for keeping proper registers.

8. He shall submit his diary every week to the Deputy Health Officer.

9. The House Drain Sub-Inspector shall serve notices, recover bills, attend to chokes and carry out all orders of the House Drain Inspector.

SANITARY INSPECTORS.

1. It is the duty of a Sanitary Inspector on taking charge of a Ward to make himself acquainted with the boundaries and sections of the Ward, the places of special sanitary importance, such as burial and burning grounds, places of public worship, tanks, wells (public and private), milch-cattle and other stables, offensive trades and occupations.

2. The Sanitary Inspector shall regularly and systematically examine the accounts, registers, books and records in his Ward office, and be responsible for these being kept in proper order.

3. It is the duty of the Inspector to inspect certain portions of his Ward in the morning and afternoon, and to ascertain that the Ward staff are properly and intelligently carrying out their duties, to note, for necessary action, all nuisances which he may observe in or about streets, houses, gullies, or other places, to examine house and sweepers' gullies, privies, latrines and urinals, to observe the sanitary state of houses, stables, and places where offensive trades are carried on, and generally to take prompt action for the removal of nuisances, and to enter a short detail of such morning and afternoon inspection in the Inspector's diary. As a rule, these inspections should be so arranged that every portion of the Ward is visited not less than once a week.

4. Any order which an Inspector may give in the execution of his duty is to be promptly obeyed by the Ward staff, and in the event of any one of the Ward staff refusing to obey or carry out such order, it is the duty of the Inspector to at once report the matter to the Deputy Health Officer. An Inspector is not to suspend any one of his staff except by order from the Commissioner, Health Officer, or Deputy

Health Officer, except in the case of wilful disobedience of order or for drunkenness.

5. An Inspector should at once, in case of a number of men combining to strike work, send an immediate report of the same by a Sub-Inspector or mukadam to the Health Officer or Deputy Health Officer, and in the meantime take such measures as he considers best to deal with the men threatening to strike work or refusing to perform duty.

6. The Inspector shall regularly inspect each week all places in his Ward for the disposal of the dead, and report any faults calling for attention.

7. It is the duty of an Inspector to make himself generally acquainted with the Municipal Act and Bye-laws, and specially acquainted with such sections and bye-laws as relate to public health and concern the Health Department.

8. He shall from time to time, and forthwith upon complaint, visit and inspect eating-houses, shops and places kept or used for the preparation or sale of butchers' meat, poultry, fish, fruit, vegetables, corn, bread, flour, milk, or any other article to which the provisions of the Municipal Act, in this behalf, shall apply, and examine any animal, carcass, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, or other articles as aforesaid, which may be therein ; and in case any such article appears to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with according to law : provided that in any case of doubt arising under this clause, he shall report the matter to his Deputy Health Officer, with the view of obtaining his advice thereon.

9. He shall, when and as directed by the Health Officer, procure and submit samples of food, drink, or drugs suspected to be adulterated for being analysed by the Analyst.

10. He shall give immediate notice to his Deputy Health Officer of the occurrence within the district of any contagious, infectious, or epidemic disease : and whenever it appears to him that the intervention of such Officer is necessary in

consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall forthwith inform the Deputy Health Officer of it.

11. He shall attend to the instructions of the Deputy Health Officer with respect to any measures which can be lawfully taken by an Inspector of Nuisances under the Municipal Act, or under any other statute or statutes, for preventing the spread of any contagious, infectious or epidemic disease of a dangerous character.

12. He shall enter from day to day, in a book to be provided by the Health Department, particulars of his inspections and of the action taken by him in the execution of his duties. He shall also keep a book or books, to be provided by the Health Officer's Department, so arranged as to form, as far as possible, a continuous record of the sanitary condition of each of the premises in respect of which any action has been taken under the Municipal Act, or under any other statute or statutes, and shall keep any other systematic records that the Health Officer may require.

13. It is the duty of an Inspector to personally instruct, clearly and patiently, his subordinates in the nature of their duty.

14. He shall attend the Office of the Deputy Health Officer daily or on particular days as directed by the Deputy Health Officer.

15. It is the duty of the Inspector to systematically examine all wells, tanks, cisterns, fountains, etc., in his Ward for the presence of mosquito larvæ in them and report to office for any further action.

16. The following procedure should be adopted in purchasing a sample of an article of food under the sale of Food and Drugs Act :—

Sale of Food and Drugs Act, applicable to Ghee only. (*Ghee Act*).

The Municipal Commissioner empowers Municipal officers under section 4 (1) to exercise the powers vested in him, by the following section, *viz.*, section 4, sub-sections (1) and (2).

Whoever sells to the prejudice of the purchaser any article of food, *viz.*, Ghee, which is not of the nature, substance or quality of the article demanded by such purchaser, shall be punished by a fine up to Rs. 100 for the first offence and up to Rs. 500 for a second or any subsequent offence.

No offence is deemed to have been committed, (*a*) where any matter or ingredient not injurious to health has been added to the article of food, &c., (*b*) where in the process of production, preparation or conveyance of such article of food some extraneous substance has unavoidably become intermixed therewith, and (*c*) where any matter or ingredient not injurious to health has been added to or mixed with such article of food, and before the sale thereof, the seller has brought to the notice of the purchaser either by a label or otherwise, the fact that such matter or ingredient has been so added or mixed.

> *N.B.*—If in compliance with a demand for ghee any article is supplied, which contains *any substance not execlusively derived from milk,* such article shall be deemed to have been sold to the prejudice of the purchaser, unless before the sale thereof the seller has brought to the notice of the purchaser the fact that it contains such substance.

In cases of prosecution, ignorance of the nature, substance or quality of the article sold is no defence.

The vendor, however, shall not be deemed to have committed an offence, if he proves to the satisfaction of the Court that—

(*a*) the article sold was purchased by him as the same in nature, substance and quality as that demanded by the purchaser and with a written warranty to the effect that it was of such nature, substance and quality;

(*b*) he had no reason to believe at the time when he sold it that the article was not of such nature, &c. ; and

(*c*) he sold it in the same state in which he purchased it.

4 (1) Persons refusing to sell any article to proper authority are liable to penalty.

(2) The officer shall, *after the purchase shall have been completed,* forthwith notify to the seller his intention to have the same analysed by the Chemical Analyser to Government and shall offer to divide the article into 3 parts to be then and there separated and each part to be marked and sealed or fastened up in such manner as its nature will permit, and shall deliver one of the parts to the seller or his agent, retain the second part for future comparison, and submit the third part to the Chemical Analyser to Government for analysis.

(*N.B.*—The article should be divided into three *equal* parts. A purchase is said to be *complete* when the article sold is received in our charge and the full *amount* for such article has been *paid to the vendor.*)

If the seller does not accept the offer of the purchaser to divide the article purchased in his presence, the Chemical Analyser to Government receiving the article for analysis shall divide the same into two parts and shall seal one of those parts and deliver the same to the purchaser who will produce it before the Court.

The Chemical Analyser certifies as follows in case of adulterated ghee:—"That it contains substance or substances not exclusively derived from milk."

A summons must be applied for within 28 days next after the commission of the offence.

(*N.B.*—The Act is about to be amended when the words 'Municipal Analyst' will be substituted for 'Chemical Analyser to Government.')

The procedure in regard to notices and summonses and the conduct of cases before a Magistrate is as follows :—

1. In making reports on which notices are demanded, the Inspector must be careful that the requirements he demands are absolutely necessary and are within the particular section of the Act under which the notice is demanded ; it is expected that an Inspector will show an intelligent discretion in the preparation of reports and in the exercise of his authority so far as may be consistent with sanitary requirements.

2. Before service of any notice, the Inspector should again satisfy himself that the requirements of the notice are necessary, and having done so serve the notice in accordance with the provisions of the Municipal Act.

3. The "checking" of notices must afterwards be done by the Inspector personally, and he must be accompanied by the Sub-Inspector of the section at the time of inspection for "checking." The notices should be checked as soon as possible after the expiry of the time mentioned in the notice and returned to office, with endorsement in accordance with the result of the inspection. Under no circumstances whatever are notices to be kept back or delayed ; should the Inspector find that the work demanded is proceeding or that there is evidence of an intention to proceed on the part of the persons concerned, then the notice should be returned to office with a report accordingly and a recommendation that further time be given.

4. The service of notices and summonses must always be made in the presence of a Sub-Inspector. Whilst serving the notice, the signature of the party either in ink or copying pencil should always be obtained on the duplicate, and in case of refusal a note should be kept to that effect with the name or names of the witnesses, if any. The exact time and date of the service should be entered.

5. The procedure in regard to service of summonses as laid down in the Municipal Act should be strictly adhered to.

6. The Inspector should have his Police Court cases carefully entered in a special book, and have notes made

in regard to each case, and be prepared with all the necessary papers, when the cases come on for hearing.

7. The Summons Clerk in the Deputy Health Officer's Office will be responsible for the forwarding to Court of all papers in connection with cases, but the Inspector must see that the papers in each of his cases are in order.

8. In stating a case or answering questions put by Magistrates or Solicitors, the Inspector must confine himself strictly to the case before the Court and answer the questions promptly, clearly and carefully.

9. All Inspectors and Sub-Inspectors must be provided with the written authority of the Municipal Commissioner to act as officers of the Municipality in accordance with the terms of the Municipal Act.

SUB-INSPECTORS.

1. A Sub-Inspector is assigned to the charge of a section or sections of a Ward, and after being instructed by the Inspector as to the nature of his duties, he should be shown the boundaries of his section or sections by the Inspector personally, after which he must make himself thoroughly acquainted with the boundaries and every portion of the Ward entrusted to him.

2. A Sub-Inspector should exercise control and supervision over the working of the scavenging and halalkhor staff of his section, assist the Inspector in the sanitary duties of the Ward, supervise the feeding of bullocks and perform such other duties as he may be ordered to perform from time to time.

3. A Sub-Inspector shall note carefully in a pocket-book any nuisance he may find, any complaints made to him by persons in his section, any acts of negligence or any faults on the part of the section staff, and report the same to the Inspector on his return daily to stables. He shall take prompt steps to remove or abate any nuisance or cause of complaint in his section. He shall daily examine and carefully inspect open drains, house and sweepers' gullies, privies, latrines and urinals, noting the state of the same.

4. A Sub-Inspector should be conversant with the sections and bye-laws of the Municipal Act dealing with nuisances and offensive trades and those concerning public health.

5. A Sub-Inspector shall keep a diary of places inspected by him, and submit it to the Deputy Health Officer weekly.

6. The Sub-Inspector shall be constantly inspecting his section. Each centre for the collection of refuse will be daily visited by him and he shall check the outgoing and incoming carts and see that all refuse is removed. He shall visit all horse and cattle stables in his section regularly and bring to the notice of the Inspector any nuisance which may be due to negligence on the part of the scavengers, halalkhors or gully flushers or on the part of the owner, or occupier of any house or premises in his section.

7. He shall visit each house in his section regularly and inspect the premises with regard to the condition of privy accommodation and the disposal of refuse and note the same in his diary and report daily to his Inspector. He shall supervise the mukadams and see that they are doing their duty.

8. He should know exactly how many carts and bullocks,—stationary and travelling,—are working in his section, the number of mukadams and male and female workers of the Department, and see that they are regularly at work at their proper places.

9. The Sub-Inspector should see that the number of labour staff allotted to each is regularly on duty during the day and check it from time to time.

10. The Sub-Inspector should see that the mukadams are regularly supervising their gangs, stationary and travelling-carts, &c.

ASSISTANT SANITARY INSPECTORS.

1. Assistant Sanitary Inspectors will have allotted to them a district which they shall systematically visit and inspect and report to the Inspector anything

which may cause or is likely to cause a nuisance. They will make a house-to-house inspection and report daily on the houses visited and their condition and observe the rules already laid down for Sub-Inspectors.

SCAVENGING MUKADAMS.

1. A mukadam should be carefully instructed by the Inspector as to his duties. A Sub-Inspector should show him the boundaries of the section or sub-section to which he is appointed.

2. A mukadam should closely watch the work of the scavenging staff under him; see that the men and women are allotted their ordered and fair share of work; supervise the loading of the scavenging and drain carts; promptly remove or report any nuisances; inspect house gullies and see that they are properly cleaned; report to the Sub-Inspector of the section any matter requiring special attention and action; and attend promptly to any complaints made by a resident of the section and report the circumstances to the Sub-Inspector at muster.

3. A mukadam should keep a note-book in which he should enter a short detail of any special matter which he has to report to his Sub-Inspector.

4. A mukadam shall keep a muster roll of the labourers and number of carts under him: forms will be supplied from the office.

HALALKHOR MUKADAMS.

1. The rules for scavenging mukadams are generally applicable to halalkhor mukadams. Besides these, the following rules are specially made for halalkhor mukadams, as their duties are of a special nature. It is their duty to see to the prompt and regular removal of all fæcal matter from privies, latrines and urinals in their section; to inspect each day a number of privies, gullies and urinals, and to report each afternoon the result of such inspection, stating the number of privies, gullies and urinals in and off each street inspected; and to make immediate arrangements for the carrying out of the work of absentees in accordance with

such orders as may be issued on the subject from time to time.

2. All privies and places within the boundaries of a halalkhor mukadam's section must be cleaned before the day's work is completed. No excuse will be accepted for work left undone, for privies not cleaned.

3. Any halalkhor mukadam coming late to work without satisfactory excuse will be summarily discharged. The utmost limit of late attendance shall be 15 minutes.

WARD CLERKS.

1. It is the duty of the Ward Clerk to take the muster of the Ward staff at such hours and in such manner as may be prescribed from time to time, to prepare and keep the muster and register books of the Ward, and all accounts, statements and abstracts as may be required from time to time.

2. The Ward Clerk is responsible to the Inspector for the receipt and despatch of all correspondence and for the careful keeping of all records, accounts and books belonging to the Ward.

3. The Ward Clerk shall prepare and keep a book in which orders issued from office are to be carefully kept and numbered and entered in an index, and submit to the Inspector the reports made by halalkhor mukadams and keep and file such reports when done with.

STABLE MUKADAMS.

1. It is the duty of stable mukadams to attend their stables in the morning at such hours as may be fixed and to supervise the yoking and going out of the Ward bullocks and carts for work.

2. Stable mukadams, in the case of absence of drivers, should promptly arrange to have other men present selected to fill their places, as carts are not to be kept in Ward stables for want of drivers.

3. Stable mukadams shall see to the issue of daily rations for bullocks, supervise the grinding and soaking of grain and the feeding and grooming of the animals.

4. Stable mukadams shall daily, morning and evening, inspect the animals on their return from work, noting animals that may be lame, sick, or unfit for duty, or which may have been ill-treated by drivers and report the same at once to the Inspector. The stable mukadam shall be personally responsible for any bullock with a fresh sore if sent out for work.

5. Stable mukadams shall supervise the cleaning and keeping in order of the stables, feeding and water troughs, and receipt, disposal and issue of all stores and supplies subject to the supervision of the Inspector.

6. Stable mukadams shall keep daily returns of all working and sick bullocks, and of all stores received and issued, and make a report of the same at evening muster to the Ward Inspector.

7. Stable mukadams shall supervise the daily shoeing of bullocks, see that the Ward farriers are doing their duties properly and efficiently, provide them with such assistance as they may require, and see that every precaution is taken to prevent injury to the animals, and keep a register showing the dates on which the bullocks of each cart were shod.

8. Stable mukadams are responsible for the filling with water of the fire buckets, and seeing that they are always kept full and in position.

9. Stable mukadams are responsible for the cleanliness of all carts and the greasing of their wheels.

10. Stable mukadams shall not leave stables until all the bullocks have returned from work, morning and evening, and are properly fed and bedded, and the night watchmen are stationed, and the stables properly closed for the night.

VETERINARY INSPECTORS.

1. The Veterinary Inspector is a qualified Veterinary Surgeon. It is his duty to examine all bullocks, to attend to all sick animals, and advise the Health Officer generally as to the treatment and working of all bullocks.

2. The Veterinary Inspector shall visit not less than two Ward stables daily at such hours as may be found convenient, and inspect, in company with the Conservancy Inspector, or the senior Sub-Inspector in the absence of the Inspector, and the stable mukadam and Ward farrier, all the bullocks in the stable, noting the result of the inspection in the diary kept in the Ward office.

3. The Veterinary Inspector may direct any animal, which in his opinion is unfit for duty, to be taken off work or removed to hospital for treatment, but no animal shall be removed from any stable without the knowledge of the Inspector.

4. The Veterinary Inspector shall carefully inspect the feet of all the animals and satisfy himself that the shoeing is being properly attended to; any neglect on the part of the Ward farriers shall be promptly brought to the notice of the Inspector, who will investigate the matter with the assistance of the Veterinary Inspector.

5. The Veterinary Inspector shall examine, at the time of his visit to Ward stables, the grass and grain, and call the attention of the Inspector to any deficiency or fault in the quality thereof.

6. In heavy, wet weather there is generally, for a short time, less cutchra found in the streets and at places of deposit; and therefore some of the weak bullocks in the Ward should be kept in stables and not sent out to work during such time as the deposit of cutchra continues less.

FARRIERS.

1. Farriers shall attend stables at such hours as may from time to time be fixed and receive each morning from the Inspector such quantity of shoes and nails as may be estimated to be sufficient for the day's work; the shoes and nails shall be made ready before the return of bullocks from morning work, after which shoeing should commence. Such assistance as farriers may require shall be given by the stable mukadams, and it is the duty of farriers to use every care and precaution in carrying out their work so as to prevent injury to the animals.

2. Farriers shall daily examine the bullocks at such hours as they may find convenient, and call the attention of the stable mukadams to any animal that may want shoeing or that may be sick or unfit for duty.

FEEDING OF BULLOCKS.

1. On arriving at stables, carts should be taken to the positions allotted to them, the bullocks unyoked, the carts placed in the manner ordered, and the bullocks taken to be watered, washed and cleaned; after having been watered, cleaned and rubbed dry, the bullocks should be fed.

2. The efficiency of the Conservancy work of the Health Department depends to a very great extent on the condition and fitness of the bullocks for work. If the bullocks are not in good health they cannot perform the work which they are kept for, and refuse which should be removed cannot be removed from near dwellings and from the City, and the most important measure of sanitation—the removal of refuse—cannot be effected.

3. No bullocks are to be fed before 3 p.m.

4. The hours of work of a Sub-Inspector on feeding duty should be from 6 a.m. to 11 a.m. (B. T.) and 3 p.m. to 6 p.m.

5. The feeding shall be supervised by a Sub-Inspector on feeding duty. The stable mukadam shall also be present.

6. Until all the bullocks are properly fed and bedded, no cart-driver shall be allowed to leave the stables.

7. It is the duty of the Sub-Inspector to see that each pair of bullocks receives the proper allowance of grass, grain, salt and oil-cake.

8. In some Wards there may be an insufficiency of feeding troughs; this can easily be made good by baskets, and baskets may be indented for if necessary.

9. Each cart-driver has a *Hatali*, and each cart-driver should be made to rub down and clean his bullocks on coming into stables.

10. In each Ward there shall be kept several grain measures both for dry and soaked grain.

11. The feeding on Sundays shall be carried out under the supervision of the Sub-Inspector on feeding duty.

12. The Inspector before leaving stables shall himself inspect the bullocks, or, if he cannot do so, depute a Sub-Inspector to walk round the stable and inspect the bullocks and report on the order in which they are tied up.

DISTRICT REGISTRARS.

1. The District Registrar is a fully qualified Medical man. It is his duty on taking charge of a district to make himself acquainted with the boundaries and sections of his district, the distribution of staff under his orders in each section, the places of special sanitary importance, *viz.*, Burial and Burning grounds, places of public worship, tanks, wells, Goanese clubs, mussafarkhanas and dharmashalas.

2. The District Registrar should regularly and systematically examine the registers, books and records in his District and is responsible for these being kept in proper order.

3. Any order which the District Registrar may give in the execution of his duty shall be promptly obeyed by the district staff and in the event of any one of them refusing to obey or carry out such orders, it is the duty of the District Registrar to at once report the matter to the Deputy Health Officer. The District Registrar should not suspend any one of his staff except by order from the Municipal Commissioner, Health Officer, Assistant to the Health Officer or Deputy Health Officer, except in the case of wilful disobedience of order or for drunkenness, and should immediately submit a report of his having done so to his Deputy Health Officer giving full reasons.

4. The District Registrar shall regularly inspect, once a week at least, all places in his district for the disposal of the dead and report any faults calling for attention. It is the duty of the District Registrar to examine the registers and account books maintained by the staff under him and to report any error in such registers or books or any neglect on the part of the Cemetery Clerks or Karkoons.

5. It is the duty of the District Registrar to make himself generally acquainted with the Municipal Act and bye-laws

and specially acquainted with such sections and bye-laws as relate to public health and concern the Health Department.

6. The District Registrar shall give immediate notice to his Deputy Health Officer and the Assistant to the Health Officer of the occurrence within the district of any contagious, infectious or epidemic disease.

7. The District Registrar shall, under the supervision of his Deputy Health Officer, be responsible for the control of all infectious diseases occurring in his district.

8. The hours of attendance in each district shall be (Bombay Time) :—

From 6-30 a.m. to 10 a.m.
and 2 p.m. to 5 p.m.

9. The District Registrar shall prescribe to patients attending the Dispensary, supervise the work of the Sub-Registrars and Nurses, make personal inquiries into every case of infectious disease, supervise the disinfection of infected houses and check the work of Birth Karkoons.

10. The District Registrar shall keep a diary which shall contain the following particulars and be submitted to his Deputy Health Officer once a week :—

(*a*) a daily account of the work done by him,

(*b*) the time of his arrival at and departure from office every morning and afternoon,

(*c*) details regarding Dispensary work and other work done by him in connection with the registration of births and deaths, disinfection, evacuation of infected premises, inoculation, vaccination, removal of sick to hospital, etc.

11. In dealing with epidemic diseases such as Plague, Cholera, and Small-pox, all other duties must be set aside and immediate attention given to cases of such diseases.

12. When such a case is reported, the District Registrar shall at once proceed to the place and institute inquiries and carry out the measures of disinfection and take the precautions laid down in the special orders dealing with epidemic diseases.

13. During epidemic seasons all boarding houses, Goanese clubs, mussafarkhanas and dharmashalas must be regularly visited and inspected by the District Registrar and his staff.

14. The District Registrar may engage, dismiss, and fine disinfection and ambulance coolies, but the Registration Ramoshees, and Birth and Death Karkoons and mukadams should not be engaged, dismissed, or fined without the approval and sanction of the Deputy Health Officer concerned. All cases requiring fine or dismissal of other subordinate staff shall at once be referred to the Deputy Health Officer, on defaulter sheet, for necessary orders.

SUB-REGISTRARS.

1. The Sub-Registrar is a qualified Hospital Assistant or Sub-Assistant Surgeon. He shall be under the direction of the District Registrar, check all deaths occurring in his section, make full inquiries in all cases of infectious disease, check the work of Birth Karkoons, supervise disinfection and carry out any orders given to him, either by the District Registrar or Deputy Health Officer.

2. The Sub-Registrar shall keep a faithful record of his work in the field books which should be submitted to the Deputy Health Officer every week.

NURSES.

1. The Nurse is a qualified midwife. The Nurse in charge of each district shall carry on house to house inspection of poor localities, ascertain fresh births, check the births reported by Birth Karkoons and attend to all delivery cases among the poor in the district.

2. The Nurse shall attend to all orders given by the District Registrar, Deputy Health Officer, Assistants to the Health Officer, or Health Officer and shall keep a record of her work in a book which shall be sent to the Deputy Health Officer every week.

TRANSFER OF STAFF.

The transfer of any member of the superintending staff of a Ward is only to be made on an order from the Municipal Office, signed by the Health Officer, Assistant to Health Officer or Deputy Health Officer.

CORRESPONDENCE.

1. All Inspectors are responsible for the accuracy of all statements, abstracts, reports, or other papers bearing their signature, and unless they can prove satisfactorily that they exercised a reasonable amount of intelligence and care in satisfying themselves as to the correctness of the document bearing their signature, they will be held personally responsible for any loss or damage the Municipality may sustain through the want of such care and precaution.

2. All reports and papers received in the Ward from the office or elsewhere should receive the prompt attention of the Inspector and be disposed of in the order of their importance. If possible, replies or reports should be made to office the day following, but papers regarding which reports have been called are not to be detained in the Ward longer than three days; if circumstances should arise preventing this rule being followed in any case, then the Inspector should return the papers giving his explanation on the fourth day.

3. All subjects for report should be enquired into by the Inspector, and the reports should state by whom the inquiries were made.

4. All reports should be short, but should give clear and distinct particulars or replies. Inspectors in their reports must confine themselves solely to the matter under reference. Should it be necessary to refer to previous reports or other information bearing on the subject, such reference should be made at the end of the report.

5. In the event of an Inspector not clearly understanding any orders or instructions sent to him or the purport of any paper, he should at once apply to office for instructions.

6. Inter-departmental correspondence should not be carried on by the Ward staff of the Health Department, but the Inspector should send an intimation to an officer, of his own rank, of the other Department, regarding any matter calling for special attention, such as fire, dangerous houses, subsidence of any road, leak or burst in any water or gas

main or pipe, choked drain, or regarding any matter of an emergent nature. A copy of the letter sent must in all cases be sent at the same time to the office.

7. Papers shall not be taken to the Inspector's house for signature. All papers must be signed by the Inspector in the Ward office. An Inspector infringing this rule renders himself liable to suspension from duty, and the Ward Clerk to a reduction in grade or to a fine.

8. The Inspector may take home any paper which may require careful study, may prepare any special report or plan at home, but ordinarily business should be disposed of in the Ward office.

9. The following registers and returns, &c., are to be sent in to office—

BY THE CONSERVANCY INSPECTOR :—(1) *Daily* :—Daily Morning Report from Inspector.
Daily Morning Report from Veterinary Inspector.
Statement of Carcass Fees received.
Offence Sheets (offence against Municipal Act).
Defaulter Sheets (workpeople, absentees, &c.).
Leave memos., applications for leave, reports *re*-persons returning from leave.
List of Cart Trips.
All Daily reports, such as on letters of complaint.
Daily returns of dead and live Rats caught.
Returns of Poisoned rat baits.
(2) *Weekly* :—Bullock Ration Indent.
Bullock Ration Expenditure.
List of places to be shown to the Health Officer.
,, ,, ,, to the Deputy Health Officer.
Rat returns to the Parel Laboratory.
Rat expenditure returns.
List of carts cleaned and tarred.
(3) *Monthly* :—Pay Abstracts.
List of persons remaining unpaid.
Unclaimed Wages Certificates.
Return of Workpeople employed.
List of Rent due by persons occupying Municipal Chawls.

Stock Returns.

Halalkhor Service Register Book.

Return of Halalkhor Service commenced and discontinued.

Account of Bullock Shoes and Nails.

Statement of Casualties among Bullocks.

Report about Weak Bullocks.

List of Defaulters among Cart Drivers, of Short Trips.

List of Fines.

Statement of Leave granted.

Indent for Petty Stores.

,, ,, Shoes and Nails.

,, ,, Veterinary Stores.

,, ,, Stationery.

Return of carts repaired in Workshops.

Return of papers in charge of Inspectors for report on certain dates or to be shown on next visit to the Health Officer or Deputy Health Officer.

Rat account registers.

Veterinary Inspector's visiting book.

(4) *Quarterly* :—Quarterly Muster Returns.

List of residential addresses of Inspector and Ward staff.

BY THE SANITARY INSPECTORS: (1) *Daily* :—Plan papers and other correspondence.

Offence Sheets (offence against Municipal Act).

Defaulter Sheets (Workpeople, absentees, &c.)

Leave memos., applications for leave, reports *re*-persons returning from leave.

All Daily Reports, such as on letters of complaint, reports of epidemic diseases, nuisances, &c.

(2) *Weekly* :—List of places to be shown to the Health Officer.

List of places to be shown to the Deputy Health Officer.

Sub-Inspector's Weekly Report of Inspection of Stables and of places where dangerous and offensive trades are carried on.

10. A book is supplied to each Inspector and kept in each Ward stable, in which orders issued should be

written. This book should be sent to office on the last Saturday of each month for inspection.

LEAVE.

1. The rules laid down in the bye-laws are applicable to Inspectors, Sub-Inspectors, and Ward Clerks. Absence from duty will only be permitted in case of sickness, or death in the family, and when such absence occurs an immediate intimation must be sent to the Ward stable; except for the above reasons, absence from duty without leave will not be excused, and any one so absent shall be liable to forfeiture of pay, to be fined, reduced, or discharged.

2. No leave, except on production of a medical certificate, or in case of a death in his family, will be given to an Inspector, Sub-Inspector, Ward Clerk or mukadam at a period when Cholera, Plague, or Small-pox is prevalent.

3. Leave will be granted in ordinary cases under the rules, so long as the efficiency of the Department is not interfered with by such leave and not more than one officer of the same grade is absent.

4. Inspectors and Sub-Inspectors will be allowed leave on every alternate Sunday, provided that the full strength of the supervising staff of the Ward is present and provided that there are no Cholera or Small-pox cases occurring in the Ward. In Wards having a senior Sub-Inspector, the Inspector must arrange that the Sub-Inspector and himself are never both off duty at the same time, and in the case of A and B Wards the two Inspectors must never be off duty together. During the absence of the Inspector in the Ward, either the Ward Clerk or stable mukadam must be on duty, and either of them must promptly attend to any order received in the Ward office during that time.

5. Inspectors will be allowed to give one day's leave at a time to a Sub-Inspector, Ward Clerk or mukadam, but not more than one day in a week without reference to office, and the leave shall be reported in the morning report of the day.

6. All other applications for leave shall be referred to the office for orders, and in the case of Sub-Inspectors, Ward

Clerks and mukadams applying for leave for more than four days, the Inspectors shall state whether the applicant can be spared and whether he is deserving of the leave applied for. Any one absenting himself, before orders are passed on his application for leave, shall be liable to be considered as absent without leave and dealt with accordingly.

7. Begaris and halalkhors may be allowed leave for any period not exceeding three months, and should be allowed to resume duty in their old places if they report themselves to the Inspector within the period of the leave granted them. Such leave granted to begaris and halalkhors should, if possible, date from the 1st of a month, so that the Muster Rolls and Pay Abstracts may not be interfered with.

8. Partial leave for general and special holidays will be given from time to time as circumstances permit.

CHAWLS OCCUPIED BY WARD STAFF.

1. The Chawls occupied by Ward begaris and halalkhors shall be regularly and carefully inspected by the Conservancy and Sanitary Inspectors and the inspection noted in the morning report.

2. Care shall be taken in the allotment of accommodation to prevent overcrowding as far as possible. The chawls shall be regularly cleaned and lime-washed and their latrines, drains and surroundings kept in thoroughly good order.

APPLICATIONS FROM WARD STAFF.

Applications from Inspectors must be addressed to the Deputy Health Officer, and from all other subordinates through the Inspector to the Deputy Health Officer and in the latter case Inspectors should add a short report in forwarding the applications.

STORES.

1. The Conservancy Inspector is personally responsible for the carts, bullocks, implements and stores and rations supplied for the use of his Ward. He must satisfy himself by constant supervision and examination that the carts are

kept clean and in proper repair, that the bullocks receive their full allowance of food, that all implements and stores and rations received are of proper quality, that the full quantities to be supplied have been delivered by Contractors or other persons, that they are in accordance with the indents, that their distribution is carried out properly and that no waste or irregularity occurs.

2. In indenting for stores, the Inspector shall be careful to apply only for such quantities as are actually required for the work in hand.

3. The Inspector shall personally receive, and give receipts for, all stores delivered at his Ward office, reject at once any stores or rations not of the approved quality, and direct the Contractor to replace them, and report the circumstances to office.

4. In each Ward stable a sample of each of the most important articles in use and obtained from the Contractor should be kept for inspection. The samples should be considered as standards up to which articles should be supplied.

5. The Conservancy Inspector is expected to visit the stables during the night not less than once a month in order to see that everything is in order.

COMPLAINTS FROM AND AGAINST WARD STAFF.

1. Before forwarding any complaint to the Deputy Health Officer, the Inspector shall make a careful investigation into the case and report the result to the Deputy Health Officer.

2. All complaints made by the Inspector against his subordinates should be clearly stated, and all complaints made by subordinates to the Inspector should be carefully enquired into without delay and the result submitted to the Deputy Health Officer.

ENGAGEMENT OF BEGARIS, CART-DRIVERS, AND HALALKHORS.

1. All Scavengers and Halalkhors should be carefully selected by the Conservancy Inspector personally, in accordance with such rules and orders as may be issued from

time to time by the Health Officer. No Scavenger or Halalkhor should be put to work except by the orders of and with the knowledge of the Conservancy Inspector.

2. The Conservancy Inspector shall see that Scavengers and Halalkhors he engages are physically capable of performing the duties they are employed for, and are not under the age of 17 years ; drivers should not be under 20.

3. The special order of questions now put to each Halalkhor or Scavenger, when first employed by the Inspector, in the presence of a Sub-Inspector and Ward Clerk, shall be strictly followed.

EPIDEMICS AND INFECTIOUS DISEASES.—RULES FOR THE GUIDANCE OF CONSERVANCY AND SANITARY INSPECTORS.

1. In dealing with epidemic diseases, such as Cholera and Small-pox, all other duties should be put aside, and *immediate* attention given to cases brought to the Inspector's notice.

2. When a case of Cholera is reported to the Conservancy Inspector, he shall at once arrange to disinfect the privies, traps and receptacles with Izal fluid, and clean and flush the gullies with Pesterine.

3. Gullies, where dead rats are found, should be well cleaned and flushed and then pesterined.

4. During epidemic seasons, all boarding-houses, Goanese clubs, mussafarkhanas and dharmashalas shall be regularly visited and inspected by the Inspector or Section Sub-Inspector.

5. The following disinfectants shall be used :—

Pesterine or Kerosine for Plague infected houses and where rats have been found ; also to prevent breeding of flies, &c., and in case of accumulations of water to prevent mosquito-breeding.

Izal Fluid for Small-pox, Cholera, Phthisis, Measles, etc., and mixed with Pesterine for Malaria as it has been found to be effective in killing larvæ.

Sulphur for fumigating after Small-pox, Measles, Phthisis, etc., and for vermins:

Izal powder for places where fluid cannot be used and for those fouled by human excreta and urine.

Permanganate of Potash for wells infected with Cholera Vibrio.

DRAIN AND SEWER CLEANING.

1. The cleaning out of all storm-water drains and channels, catchpits and drain entrances should commence on the 1st of May in each year.

2. During the monsoon season, the Inspector shall give special instructions to his Ward staff, regarding the keeping clear of refuse, all gratings and openings carrying off storm water, in order to prevent flooding so far as is possible; and during periods of heavy rainfall special men should be told off to attend to such places as from their low level are most liable to become obstructed.

3. All covered drains and sewers should be opened periodically and examined with a view to ascertain their state of cleanliness, and a memorandum of the result made in the drain-cleaning register. When a large drain or sewer is found to be in such a state as to require cleaning, a report must be made to the office.

4. In cleaning covered sewers into which it is necessary to send men, the following procedure should be strictly followed:—

(*a*) The manholes should be removed along the whole sewer at least two hours before any one is permitted to enter it.

(*b*) Ventilators should be inserted into the sewer at convenient points as soon as the manholes are opened. The ventilators should be placed in such positions in the sewer as shall give the men below the fullest advantage from the fresh air drawn into it. After the expiry of the period already fixed to elapse after the removal of the manhole covers, the state of the atmosphere in the sewer should be tested by the Inspector in the following manner:—A lighted kerosine oil lamp of the ordinary hurricane pattern should be lowered into the sewer close to the water or silt, and the silt agitated, and the lamp kept there for at least 15 minutes. If the flame of the lamp burns clearly and steadily, the Inspector may assume that the air in the sewer at this place is sufficiently pure to permit of the entrance of the work-people. But only down such manholes as have been so tested should men be sent into the sewer.

c) The first man to enter the sewer should have a lamp, and he should proceed cautiously along the sewer towards the next manhole for a distance of 20 yards, carefully observing all the time whether the lamp burns brightly or not, and then suspend the lamp in the sewer by such means as are convenient.

(*d*) As a rule, all sewers should be cleaned by working with the flow of sewage, and all possible expedition should be used in carrying out the work by sending gangs of men into the sewer at different places. Care should be taken that each gang is working between lamps; not only will this give the men more light, but it will also give them confidence and warn them of the state of the air in the sewer. On any lamp going out the men should at once leave the sewer by the nearest manhole.

5. Before commencing the cleaning of sewers, the Inspector shall see that all the necessary implements are on the spot,—buckets, baskets, powrahs, crowbars, picks, ropes and lamps; a spare coil of ropes shall be kept lying close to each manhole for use in case of an accident.

6. The Inspector shall, during the day, visit the work as often as possible and satisfy himself that all precautions possible for the safety of the workmen are being taken. The work should be carried out under the direct supervision

of a senior Sub-Inspector with such assistants as may be necessary.

7. The men working in the sewer should not be allowed to remain down longer than half an hour at a time: they should be ordered up for rest after half an hour, and a fresh gang sent down to take their place.

8. Great care must be given to drain cleaning, as the lives of the workmen may be placed in danger by the neglect of precautions. Inspectors are particularly cautioned about this most important part of their duties.

9. In the event of any of the men in the sewer becoming ill, every possible endeavour should be made to bring the sufferer to the surface of the ground, and the following method of treatment immediately adopted:—the sufferer should at once be removed to the open air and measures to excite breathing should be commenced; every moment of delay lessens the chances of restoration to life; all clothes on the body should be loosened. The treatment should now continue as follows:—the sufferer should be placed prone on the face with one arm under the forehead, the mouth should be opened, the tongue drawn forward and the mouth and nostrils cleansed; then turned on the side, the head being supported, and if breathing has not commenced, again turned on the face, and again gently round to the side (if water is at hand it should be dashed on the face) and on to the back; the head and shoulders should be raised; the arms should now be grasped above the elbows and drawn gently but firmly upwards above the head, and kept above the head for 2 seconds, and then lowered to the sides against which they should be gently pressed; the raising of the arms followed by the depression of them, in the manner described, should be continued until breathing has been restored or until, in the opinion of a medical man, life has become extinct.

The object of these movements is to excite respiration. On the restoration of breathing, measures should be taken to restore the warmth of the body and promote circulation. Warm clothes should be ready, the body should be rubbed dry and wrapped in dry clothes.

When the patient is able to swallow, warm water or any spirit may be given.

10. On the report of an accident medical aid should at once be called.

11. When it is believed that an accident has occurred in a sewer, the first measure obviously is to remove all human beings out of the sewer; the number of persons in the sewer should at once be ascertained; the assembling of persons around the manholes or entrances to the sewer should be prevented.

UNIFORM.

1. All European and native Inspectors and Assistant Inspectors should wear a uniform pattern of dress, blue serge or khaki trousers, with patrol jacket of the same cloth made with standing military fashion collar and helmet covered with khaki.

2. Native Sub-Inspectors and Mukadams should wear the following uniform:—Mussulman and Hindoo Sub-Inspectors and Mukadams–jacket and trousers of khaki with khaki pugri neatly folded. All other classes should dress either as Europeans or natives.

3. Brass plates with numbers which will be supplied by the Department should be worn by all scavengers,—men and women,—during hours of duty: by the men on the right arm, and by the women suspended round the neck. Halalkhors should wear belts round the waist.

4. Section Mukadams shall be responsible for their labourers wearing the badges during working hours. Badges lost should be replaced by the persons losing them.

5. Registration Karkoons and Hearse Drivers and Milch Cattle Stable Ramosees will wear the prescribed uniform.

FIRE PRECAUTIONS.

The night Ramosees shall come on duty at 5-30 P.M. It shall be their duty to go round the whole stables once every hour and satisfy themselves that everything is in proper order. They shall see that all the fire buckets are in position and filled with water. The Inspector shall arrange that not less than eight cart-drivers sleep in the stables at night beginning with the drivers Nos. 1 to 8, and thus through the whole strength of drivers by rotation. In the case of F and G Wards, 2 men will be sufficient. The first thing to be done in the case of a fire breaking out is to let loose all the bullocks and drive them out of the stable, and make every endeavour to put out the fire. Intimation shall be sent to the nearest Police Chowkey and Municipal Chawl for assistance, to the Ward Inspector, Health Officer and Deputy Health Officer.

GENERAL RULES.

1. All Inspectors and other officers of the Health Department should be courteous and obliging to all persons with whom they come in contact in carrying out the duties of their appointments.

2. Prompt, willing and intelligent compliance with orders will ensure cordiality between the executive officers of the Health Department and the outdoor staff, and will go far towards making the working of the Department easy and smooth.

3. It is the duty of the Inspector to promptly report any delinquency on the part of his subordinates, stating shortly the nature of the case.

4. In addition to making such reports as an Inspector may be required to do from time to time, he should bring at once to the notice of the Health Officer, Assistant to Health Officer or Deputy Health Officer, any matter or suggestion which he may consider of importance; and all matters of moment coming under his notice, such as particular accidents, fires, falling of houses, outbreak of sickness in any particular locality, and generally any matter which the Inspector may think it advisable, the Health Officer, Assistant to Health Officer, or Deputy Health Officer should be informed of.

5. The strictest sobriety is required of all Inspectors and subordinates, and any one attending duty under the

influence of liquor will be severely dealt with, and nothing in the offender's character or position shall affect punishment. The following punishments will be inflicted by the Health Officer for drunkenness :—

For the first offence, a fine such as the Health Officer may consider sufficient to meet the case.

For the second offence, reduction to the next lower grade in the case of Inspectors, Sub-Inspectors and Clerks ; and in other cases, dismissal.

For the third offence, immediate suspension pending the order of the Municipal Commissioner.

In the case of Inspectors and Sub-Inspectors, the punishments for second and third offences are subject to the approval of the Municipal Commissioner.

It is not optional on the part of the Health Officer to overlook any offence of this nature.

6. Strict honesty and truthfulness in all matters will ensure confidence and trust. Inaccurate statements, concealment of facts, and want of zeal and interest in work cannot conduce to confidence.

Wilful mis-statements and concealment of facts and falsification of records will lead to immediate dismissal.

7. No person, not a Municipal officer, is to be permitted to enter into any Health Department stables without permission from office ; and no person, not an officer of the Health Department, is to be permitted to take or examine any article belonging to the Health Department without permission.

8. While paying Begaris and Halalkhors, the amount of pay due to each person should be stated in the language of the person to be paid.

9. No Inspector or Sub-Inspector should borrow money from any person residing in the section where he works.

10. No anonymous complaints will be attended to either by the Executive Health Officer, Assistant Health Officer, or Deputy Health Officer. Any of the staff

wishing to make any complaints must do so over his signature or mark. Any false allegations made therein will render the maker liable to dismissal from service.

11. The foregoing rules are intended for general guidance and will take the place of all previous standing orders, and remain in force until altered or cancelled with the sanction of the Municipal Commissioner; and such orders as may be issued by the Health Officer, Assistant Health Officer, or the Deputy Health Officer, from time to time, shall be read and enforced in connection with these rules.

12. The Sanitary and Conservancy branches should work in harmony, and it is expected that each branch will render to the other such assistance in the work of the Department as lies in its power.

GUIDE TO PUBLIC HEALTH LAWS.

(*Notes are local to Bombay.*)

The City of Bombay Municipal Act of 1888 *as modified up to* 1st *May* 1912.

(*a*) *The City.*—Means the City of Bombay.

(*b*) *The Corporation.*—Means the Municipal Corporation of the City of Bombay.

(*c*) *Councillor.*—Means a member of the Corporation.

(*d*) *The Commissioner.*—Means the Municipal Commissioner for the City of Bombay.

(*e*) *Owner.*—When used in reference to any premises means the person who receives the rent of the said premises, or who would be entitled to receive the rent thereof if the premises were let; and includes :—

I. An Agent or Trustee who receives such rent on account of the owner.

II. A receiver appointed by any Court.

(*f*) A person is deemed "*to reside*" in any dwelling which he sometimes uses, or some portion of which he sometimes uses, though, perhaps, not uninterruptedly, as a sleeping apartment.

(*g*) *Building.*—Includes a house, out-house, stable, shed, hut and every other such structure whether of masonry, bricks, wood, mud, metal, or any other material whatever.

(*h*) *Water Work.*—Includes a lake, stream, spring, well, pump, reservoir, cistern, tank, duct, whether covered or open, sluice, mainpipe, culvert, engine and any machinery, land, building or thing for supplying or used for supplying water.

(*i*) *Drain.*—Includes a sewer, pipe, ditch, channel or any other device for carrying off sewage, offensive matter, polluted water, sullage, waste water, rain water or subsoil water, and any ejectors, compressed air mains, sealed sewage mains and special machinery or apparatus for raising, collecting, expelling or removing sewage or offensive matter to the sewage outfall.

(*j*) *Land.*—Includes land which is built upon or covered with water.

(*k*) *House Gully.*—A passage or strip of land, constructed, set apart or utilized for the purpose of serving as a drain or of affording access to a privy, urinal, cesspool or other receptacle for filthy or polluted matter, to municipal servants or to persons employed in the cleansing thereof or in the removal of such matter therefrom.

(*l*) *Street.*—Includes any highway and any causeway, bridge, viaduct, arch, road, lane, footway, square, court, alley or passage, whether a thoroughfare or not over which, the public have a right of passage or access or have passed and had access uninterruptedly for a period of 20 years.

(*m*) *Public Street.*—Means any street heretofore levelled, paved, metalled, channelled, sewered or repaired by the Corporation, and any street which becomes a public street under any of the provisions of the Act.

(*n*) *Private Street.*—Means a street which is not a public street.

(*o*) *Nuisance.*—Includes any act, omission, place or thing which causes or is likely to cause injury, danger, annoyance or offence to the sense of sight, smelling or hearing or which is, or may be, dangerous to life or injurious to health or property.

(*p*) *Dangerous Disease.*—Means Cholera, Plague, Small-pox, Enteric or Typhoid, Relapsing Fever, Malaria, Phthisis, Measles, Whooping Cough, Erysipelas, Scarlet Fever, Diphtheria, Sleeping Sickness, Yellow Fever, Kala-Azar, and any endemic, epidemic, or infectious disease by which the life of man is endangered.

Obligatory duties of the Corporation–Section 61—

(*a*) Construction, &c., of drains and drainage works, and of public latrines, urinals and public conveniences.
(*b*) Supplying water.
(*c*) Scavenging, &c.
(*d*) Abatement of all nuisances.
(*e*) Regulation of places for the disposal of the dead.
(*f*) Registration of births and deaths.
(*ff*) Public vaccination.
(*g*) Prevention of the spread of dangerous diseases.
(*gg*) Public medical relief.
(*h*) Provision of markets and slaughter houses.
(*i*) Regulation of offensive and dangerous trades.
&c. &c. &c. &c.

Section

68 (1) The Municipal Commissioner empowers in writing any Municipal Officer to perform under the Municipal Commissioner's control and subject to his revision, any of the powers, duties or functions, described in sub-section (2), and the word "Commissioner" includes such officer so empowered.

(2) The sections, sub-sections and clauses of this Act referred to in sub-section (1) (*pertaining to the Health Department*) are the following:—
82–84–112–228–234–240–243 (2)-246 A–248–249–249A–250(2)–251–251B–253–257–258 (*a*), (*b*), (*c*)–374–375–377–379–379 A–383–384(*a*)–394–396(1)–410(1)–412 (1), (2)–413(1)–415–416–422–424 (1)–425 (1)–427 (3)–479 (5)–488 and 517 (*a*).

Leave of Absence, Acting Appointments, &c.

Section

81 Standing Committee to frame regulations for grant of leave, &c.

82 Power of appointing Municipal Officers vests in the Municipal Commissioner.

83 Power of suspending, punishing and dismissing vests in the authority by whom such officer or servant is appointed.

84 Leave of absence may be granted by the Municipal Commissioner.

86 Municipal Officer or servant not to be interested in any contract, &c., with the Corporation.

141 Water tax on what premises to be levied.

142 Halalkhor tax on what premises to be levied.

181 Exemptions from the tax on vehicles and animals kept for Municipal purposes.

220 *Municipal Drains.*—Municipal drains to be under the control of the Municipal Commissioner.

220*a* Vesting of water courses.

221 Drains to be constructed and kept in repair by the Municipal Commissioner.

222 Power of making drains.

223 Buildings should not be erected without permission over any Municipal drain.

224 Alteration and discontinuance of drains.

225 Cleansing of drains.

227 *Drains of Private Streets and Drainage of Premises.*—Power to connect drains of private streets with Municipal drain.

228 Power of owners and occupiers of premises to drain into Municipal drains.

229 Connections with Municipal drains not to be made except in conformity with section 227 or 228.

Section.

230 Rights of owners and occupiers of premises to carry drains through land belonging to other persons.

231 Municipal Commissioner may enforce drainage of undrained premises situated within a hundred feet of a Municipal drain.

232 Municipal Commissioner may enforce drainage of undrained premises, not situated within 100 feet of a Municipal drain.

232*a* Municipal Commissioner may enforce drainage of premises in combination.

233 Municipal Commissioner may close or limit the use of existing private drains.

233*a* Vesting and maintenance of drains for sole use of properties.

234 New buildings should not be erected without drains.

235 Excrementitious matter not to be passed into cesspool.

236 Obligation of owners of drains to allow use thereof or joint ownership therein to others.

237 How right of use or joint ownership of a drain may be obtained by a person other than the owner.

238 Municipal Commissioner may authorize person other than the owner of a drain to use the same or declare him to be a joint owner thereof.

239 Sewage and rain water drains to be distinct.

240 Drains should not pass beneath buildings.

241 Cesspools not to be constructed beneath buildings nor within 20 feet of any well, &c.

242 Right of Corporation to drains, &c., constructed, &c., at charge of Municipal Fund on premises not belonging to the Corporation.

243 All drains and cesspools to be properly covered and ventilated.

Section

244 Municipal Commissioner may affix pipes to any building, &c., for ventilation of drains, &c.

Disposal of Sewage.

245 Municipal Commissioner may appoint places for emptying of drains and disposal of sewage.

246 Provision of means for disposal of sewage.

Water Closets, Privies, Urinals, &c.

246*a* (1) No water closet or privy for any premises should be constructed except with the written permission of the Municipal Commissioner who shall prescribe

(2) (*a*) Whether the premises shall be served by a water closet or by a privy, and

(*b*) the site or position of each water closet or privy.

(3) If any water closet or privy is constructed in contravention of subsection (1), the Municipal Commissioner, with the approval of the Standing Committee, can demolish the same.

247 (1) Water closet and other accommodation, including washing and bathing places, should be provided in buildings newly erected or re-erected, and

(2) In prescribing such accommodation the Municipal Commissioner may determine in each case—

(*a*) whether water closet or privy should be erected, and

(*b*) prescribe the site or position of each water closet, privy, urinal, or bathing or washing place, and their number.

248 When any premises are without a water closet or privy or urinal or bathing or washing place, or such existing accommodation is insufficient, inefficient, or on any sanitary grounds objection-

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able, the Municipal Commissioner, with the approval of the Standing Committee, may take action for such requirements.

N. B.—The usual rule of the Health Department is to demand one privy seat for every 5 rooms, each occupied as a separate tenement.

249 Power to require privy accommodation, &c., for factories, &c., in which persons exceeding 20 in number are employed.

Unhealthy Privies.

249*a* When any privy by reason of its not being sufficiently detached from any building is likely to cause injury to health, the Municipal Commissioner, with the previous approval of the Standing Committee, may ask for following requirements:—

(*a*) To close up such privy and to provide in lieu thereof water closet or privy or urinal as the Municipal Commissioner may prescribe;

(*b*) To provide an open "chawk" within the owner's own limits, 3 feet in width, between the said privy and the building.

250 Provisions as to privies:—

(*a*) Open chawk, or air space 3 feet in width;

(*b*) Screen walls;

(*c*) Trap doors not to open into street.

251 Provisions as to water closets.

251*a* Position of water closets and privies:—

(*a*) Not to be directly over or under any room or building other than another water closet or privy or a bathing place, bathroom or terrace.

(*b*) Not to be within a distance of 20 ft. from any well, &c.

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251*b* Use of places for bathing or washing clothes or domestic utensils.

252 Public conveniences.

Inspection.

253 Drains, &c., on private premises to be subject to inspection and examination.

254 Power to open ground, &c., for purpose of such inspection and examination.

255 When the expenses of inspection and examination are to be paid by the Municipal Commissioner.

256 When the expenses of inspection and examination are to be paid by the owner.

257 Municipal Commissioner may require repairs, &c., to drains, ventilation shaft, or pipe, cesspool, house gully, water-closet, privy, latrine, urinal, bathing or washing place to be made.

257*a* Cost of inspection and execution of works in certain cases.

258 No person shall—

(*d*) Drop, pass, or place, or cause or permit to be passed, dropped, or placed into or in any drain, any brick, stone, earth, ashes or any substance or matter by which such drain is likely to be obstructed ;

(*e*) Pass, or permit, or cause to be passed into any drain, provided for a particular purpose, any matter or liquid for the conveyance of which such drain has not been provided ;

(*N. B.*—Action for passing dung into drains in milch cattle stables is taken under these sub-sections).

(*f*) Discharge into any drain any hot water, steam, fumes, or any liquid which would prejudicially affect the drain.

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260 Municipal Commissioner may execute certain works, under this chapter, without allowing option to persons concerned of executing the same.

265 Power of carrying water mains, etc.

267 Prohibition of building and other acts which would injure sources of water-supply.

268 Buildings, &c., not to be erected over Municipal water main without permission.

274 Provision as of storage cisterns and other fittings, &c., to be used for connections with water-works.

279 Power to cut off private water-supply or to turn off water.

281 Water pipes not to be placed where water will be polluted.

294 Minimum width of new public streets—40 feet if made for carriage traffic or 20 feet if such streets be made for foot traffic only.

Provisions concerning Private Streets.

302 Notice of intention to lay out *new private streets* to be given to the Municipal Commissioner.

303 Level, direction, width and means of drainage of *new private streets* and of the buildings on either side thereof to be determined by the Municipal Commissioner.

305 Levelling and draining of private streets.

306 Power to declare private streets when sewered, &c., to be public streets.

316 Prohibition of tethering of animals in public streets.

333 Manner of laying gas pipes ; (gas pipes should be at the greatest possible distance from water pipes and gas pipes shall be laid above the water pipe when it is necessary for a gas pipe to cross a water pipe).

335 Buildings, &c., not to be erected without permission over Municipal gas pipes.

Building Regulations.

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337 Notice to be given to the Municipal Commissioner of intention to erect a building.

338 Municipal Commissioner may require plans and other documents to be furnished.

339 Municipal Commissioner may require plans, &c., to be prepared by a licensed Surveyor.

340 Additional information, &c., may be required.

341 Effect of non-compliance with requisition under section 338 or 340.

342 Notice to be given to the Municipal Commissioner of intention to make additions, &c., to a building.

343 Plans and additional information to be called for.

345 Within 30 days, the applicant must receive a reply of approval or disapproval or for production of further particulars.

347 When work may be commenced.

Provisions as to Structure, Materials, &c.

348 Buildings which are to be newly erected—

(*c*) Shall not be constructed on any site which has been filled up with excrementitious matter, &c.;

(*d*) The plinth to be at least 2 feet above the centre of the nearest street;

(*e*) Shall be so constructed that the whole of at least one side of every room thereof shall either be an external wall or abut on an interior open space. Such external wall, except where it faces a street of not less than 15 feet in width, shall have between it and the boundary line of the owner's premises an open space, extending

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throughout the entire length of such wall, at least two feet wide or in the case of a chawl or building intended to form a range of separate rooms for lodgers, at least 5 feet wide. Such interior open space shall have an area equal to not less than 1-10th of the aggregate floor area of all the rooms abutting thereon and shall not be in any direction less than 6 feet across. And every open space, whether exterior or interior, required by this clause shall be and be kept free from any erection thereon and open to the sky and shall be and be kept open to access from each end thereof;

(*f*) The rooms shall be in every part at least 10 feet in height from the floor to the ceiling, except a room in the roof thereof;

(*g*) The room in the roof of a building shall have an average height of at least 8 feet from the floor to the ceiling and a minimum height of not less than four feet;

(*h*) Every room shall have a clear superficial area of not less than 100 square feet;

(*i*) The ventilation of each room should be by doors and windows which open directly into the external air and have an aggregate opening equal to not less than ¼th of the superficial area of the side of the room which faces an open space.

349 Roofs and external walls of buildings not to be of inflammable material.

349*a* Maximum height of buildings,—70 feet.

349*b* Height of buildings with reference to width of streets.

353*a* Completion Certificates; permission to occupy or use.

Sanitary Provisions.

Section

365 Cleansing of streets and removal of refuse.

367 Provision and appointment of receptacles, depôts, and places for refuse, &c.

368 Duty of occupiers to collect and deposit refuse, &c.

369 Provision may be made by Municipal Commissioner for collection, &c., of excrementitious and polluted matter.

370 Collection and removal of excrementitious and polluted matter when to be provided for by occupiers.

371 Halalkhor's duties may not be discharged by private individuals without Municipal Commissioner's permission.

372 Prohibition of—

(*a*) Failure to remove refuse, &c. (which should not be allowed to accumulate on the premises for more than 24 hours) ;

(*b*) Removal of refuse, &c., without proper precautions ;

(*c*) Failure to clear away any refuse, &c., which drops during removal ;

(*d*) Leaving filth carts, &c., unnecessarily in the streets ;

(*e*) Throwing or placing refuse, &c., in any place not appointed for the purpose ;

(*f*) Allowing filthy matter to flow or soak or to be thrown from any premises in such a way as to cause nuisance.

373 Presumption as to offender : it shall be presumed that the offence has been committed by the occupier of a building or land, if it be shown that refuse, etc., was thrown or placed in contravention of (*e*) from that building or land.

Inspection and Sanitary Regulation of Premises.

Section

374 Power to inspect premises for sanitary purposes.

375 Cleansing and lime-washing of any building.

376 Abandoned or unoccupied premises.

377 Neglected premises. Notice for removal of kutchra, rank vegetation, &c.

378 Buildings, U. H. H.

379 Municipal Commissioner may call for a statement of accommodation, *viz.*, total number of rooms, cubic capacity of each room, &c.

379*a* Overcrowded dwellings—(1) Application to be made to a Presidency Magistrate who prescribes the maximum number of persons in each room and may require the owner to abate overcrowding within 10 days.

(4) A room used exclusively as a dwelling shall be deemed to be overcrowded when the floor space to each adult is less than 25 square feet or 250 cubic feet (two children under ten years of age counting as one adult).

(5) A room *not exclusively* used as a dwelling shall be deemed to be overcrowded when the floor space to each adult is less than 30 square feet or 300 cubic feet (two children under ten years of age counting as one adult).

380 Insanitary huts and sheds.

381 Filling in of pools, wells, ponds, quarry holes or low ground which are a nuisance.

382 Dangerous quarrying may be stopped.

383 Removal and trimming of trees, shrubs and hedges.

384 Prohibition as to keeping animals: No person

(1) (*a*) Shall keep any swine without the written permission of Municipal Commissioner;

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(*b*) Shall keep any animal on his premises so as to be a nuisance or dangerous to any person ;

(*c*) Shall feed any animal upon excrementitious matter, dung, stable refuse, &c.

(2) Any swine found straying may be destroyed.

385 Removal of carcasses of dead animals.

Regulation of Public Bathing, Washing, &c.

386 Places for public bathing, &c., to be fixed by the Municipal Commissioner.

387 Regulation of use of public bathing places, &c.

388 Prohibition of bathing, &c., contrary to order or regulation.

389 Prohibition of corruption of water by steeping therein animal or other matter, &c.

Regulation of Factories, Trades, &c.

390 Factory, &c., not to be newly established without Municipal Commissioner's permission.

391 Furnaces used in trade or manufacture to consume their own smoke.

392 Sanitary regulation of factories, bake-houses, &c.

393 Prohibition of the use of steam whistle, or steam trumpet without Municipal Commissioner's permission.

394 Certain things not to be kept, and certain trades and operations not to be carried on without a license.

395 Prohibition of corruption of water by chemicals, &c.

396 Inspection of premises used for manufactures under section 394.

397 Regulation of washing of clothes by washermen.

Section

Maintenance and Regulation of Markets and Slaughter Houses.

398 What to be deemed Municipal markets and slaughter houses.

399 Provision of new Municipal markets and slaughter houses.

400 Municipal markets and slaughter houses may be closed.

401 Prohibition of sale in a Municipal market without license of Commissioner.

402 Opening of new private markets.

403 Private markets not to be kept open without a license from the Municipal Commissioner.

404 Prohibition of sale in unauthorised private market.

405 Private markets and slaughter houses to be paved and drained.

406 Regulations to be framed for markets and slaughter houses.

410 Prohibition of sale of meat, fish, &c., except in a market. (This does not apply to fresh fish sold from or exposed for sale in a vessel in which it has been brought direct to the seashore after being caught at sea.)

411 Butchers and persons who sell the flesh of animals to be licensed.

412 Prohibition of import of cattle, sheep, goat, &c., into the city without permission.

413 *Inspection of places of sale, &c.*—Municipal Commissioner may enter any place where slaughter of animals or sale of flesh contrary to the provisions of this Act is suspected.

414 Provision for inspection of articles exposed for sale for human food (includes inspection of animals, carcasses, meat, poultry, game, flesh, fish, fruit, vegetables, corn, flour, ghee, milk, &c).

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415 Unwholesome articles, &c., to be seized.

416 *Perishable articles* to be destroyed, *viz.*, meat, fish vegetables, &c., if found diseased, unsound, unwholesome or unfit for human food.

417 *Non-perishable articles* :—

(1) Any animal or any article not of a perishable nature seized under section 415 shall forthwith be taken before a Presidency Magistrate.

(2) If the Magistrate is satisfied that such animal or article is diseased, unsound, or unwholesome or unfit for human food, he may cause the same to be destroyed.

417*a* Penalty for representing any article (*Ghee*) to be what it is not.

Prevention of spread of Dangerous Diseases.

421 Medical Practitioners to give information of existence of dangerous disease.

422 Inspection of places for the purpose of preventing the spread of dangerous disease.

423 Prohibition of use for drinking of water likely to cause dangerous disease.

424 Municipal Commissioner may order removal of patients suffering from a dangerous disease to Hospital.

425 Disinfection of buildings, &c.

426 Destruction of huts and sheds, when necessary.

427 Place for disinfection may be provided.

428 Persons suffering from dangerous disease not to enter a public conveyance without notifying the same.

429 Municipal Commissioner to provide ambulances and vans for conveyance of patients.

Section

430 Provisions as to carriage of persons suffering from dangerous disease in public conveyances.

431 Public conveyance which has carried a person suffering from dangerous disease must be disinfected.

432 Infected articles not to be transmitted, &c., without previous disinfection.

433 Infected buildings not to be let without being first disinfected.

Special Sanitary Measures.

434 Municipal Commissioner may take special measures on outbreak of any dangerous disease (*e. g.*, small-pox, foot and mouth disease amongst cattle and glanders in horses).

Disposal of the Dead.

435 Places for disposal of the dead to be registered.

436 Provision of new places for disposal of the dead.

437 New places for the disposal of the dead not to be opened without permission of Municipal Commissioner.

438 Governor in Council may direct the closing of any place for disposal of the dead.

439 Governor in Council may sanction the re-opening of places, which have been closed, for the disposal of the dead.

440 Burials within places of worship and exhumations not to be made without the permission of the Municipal Commissioner.

441 (*c*) No person shall carry a corpse along any street, along which the carrying of corpses is prohibited by a public notice.

(*f*) No person shall bury any corpse at a less depth than 6 feet from the surface of the ground.

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(*g*) No person shall build or dig any grave at a less distance than 2 feet from the margin of any other grave or vault.

(*i*) No person shall re-open a grave or vault for the interment of a corpse without the written permission of the Municipal Commissioner.

Vital Statistics.

442 Appointment of registrars for births and deaths.

443 Registrars to reside in their respective districts.

444 Register books of births and deaths to be supplied.

445 Registrars to inform themselves of all births and deaths.

446 Information of birth to be given within seven days.

447 Information respecting finding of new-born child to be given.

448 Officers to be appointed to receive information of deaths at places for disposal of the dead.

449 Information of death to be given at the time when the corpse of the deceased is disposed of.

450 Medical Practitioner who attended a deceased person to certify the cause of his death.

451 Preparation of register books of deaths and of mortality returns, &c.

452 Correction of errors in birth and death registers. (An error of fact or substance cannot be corrected, except on the production of a declaration made before a Magistrate by two persons and certified by such Magistrate to have been made in his presence.)

453 Registration of name of child or of alteration of name.

Taking of a Census.

454 to 460—Taking of a Census.

Bye-laws.

Section

461 The Corporation may make bye-laws with respect to—

(*a*) Construction, maintenance, &c., of drains, cesspools, water-closets, privies, urinals, &c.;

(*b*) Water-supply ;

(*c*) Structure of walls, &c.;

(*d*) Provision and maintenance of sufficient open space for ventilation of buildings ;

(*e*) Provision of house gullies ;

(*f*) Control and supervision of all dangerous and offensive trades ;

(*g*) Construction, &c., of milch cattle stables ;

(*h*) Cleanliness, &c., in dairies ;

(*j*) Notice whenever any milch animal is suffering from any dangerous disease ;

(*k*) Inspection of markets, slaughter-houses, &c.;

(*l*) Control and supervision of butchers ;

(*m*) Regulations for Municipal markets, &c.;

(*p*) Regulations for places for disposal of the dead ;

(*q*) For accurate registration of births and deaths.

462 Punishment may be imposed for breach of bye-laws.

463 Bye-laws must be confirmed by Government.

Penalties.

471 Prescribes penalties.

472 Continuing offences to be punished after a fresh conviction with a daily fine.

473 Offences punishable under the Penal Code.

474 Punishment for acquiring share or interest in contract, &c., with the Corporation.

475 Punishment of offences against section 267.

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476 Punishment of offences against section 391.

477 Extent of penal responsibility of agents and trustees of owners.

479 (3) Licenses and written permissions may be suspended or revoked by the Municipal Commissioner.

482 Consent, &c., of Commissioner may be proved by written document under his signature.

Service of Notices, &c.

483 Notices, &c., to be served by persons authorized by the Municipal Commissioner.

484 Service of notices, &c., how to be effected on owners of premises and other persons.

485 Service of notice, &c., on "owner" or "occupier" of premises how to be effected—

(*a*) By giving or tendering the said notice, &c., to the owner or occupier;

(*b*) If the owner or occupier is not found, by giving or tendering the said notice, &c., to some adult male member or servant of the family of the owner or occupier;

(*c*) If none of the means aforesaid be available, by causing the said notice, &c., to be affixed on some conspicuous part of the building or land to which the same relates.

486 The three last sections (483-484 and 485) are inapplicable to Magistrates' Summonses.

487 Signature on notices, &c., may be stamped.

Power of Entry.

488 Municipal Commissioner, &c., may enter any premises for purposes of inspection, survey or execution of necessary work.

Section

Enforcement of Orders to execute Works, &c.

489 Works, &c., which any person is required to execute may in certain cases be executed by the Municipal Commissioner at such person's cost.

Recovery of Expenses by the Commissioner.

491 Expenses recoverable under this Act shall be payable on demand ; and, if not paid on demand, may be recovered as an arrear of property tax.

492 If the defaulter is the owner of premises in respect of which expenses are payable, the occupier to be also liable for payment thereof.

499 In default of owner, the occupier of any premises may execute required work and recover expenses from the owner.

500 Limitation of liability of agent or trustee of owner.

507 Remedy of owner of building or land against occupier who prevents his complying with any provision of this Act.

508 Power to summon witnesses and compel production of documents.

Proceedings before Magistrates.

513 Cognizance of offences by Presidency Magistrates.

514 Complaints of offences shall be made before Magistrates within three months next after the commission of such offence.

515 Complaint by any person concerning nuisances may be made to a Magistrate.

516 Offenders against this Act may in certain cases be arrested by Police officers.

Section

Legal Proceedings.

517 Provisions respecting institution, &c., of Civil and Criminal actions and obtaining legal advice.

521 All Municipal servants are public servants within the meaning of section 21 of the Indian Penal Code.

522 Co-operation of Police for carrying into effect and enforcing provisions of this Act.

523 Computation of time.

527 Protection of Municipal officers or servants acting under this Act against suits.

HEALTH DEPARTMENT BYE-LAWS.

Revised Bye-laws with respect to Buildings.

"*Plinth*" means the portion of the external wall between the level of the street and the level of the first floor above the street, and, except in the case of stables, godowns, and buildings of the warehouse class, shall in no part be less than 2 feet above the level of the centre of the adjacent portion of the nearest street or below such standard level as may from time to time be fixed by the Commissioner.

"*Topmost storey*" means the uppermost storey in a building, whether constructed wholly or partly in the roof or not, and whether used or constructed or adopted for human habitation or not.

"*Public Building,*" except where otherwise defined means a building used or constructed or adopted to be used, either ordinarily or occasionally, as a place of public worship, or as a hospital, college, school (not being merely a dwelling house so used), hotel, restaurant (not being merely a shop so used), theatre, public hall, public concert-room, public lecture-room, public exhibition-room, or as a public place of assembly or entertainment for persons admitted thereto by tickets, or otherwise, or used or constructed or adopted to be used, either ordinarily or occasionally, for any other public purpose.

"*Building of the warehouse class*" means a warehouse, factory, manufactory, brewery, or distillery, or other place in which operations are conducted by mechanical power.

"*Domestic building*" means a dwelling house or an office building or other out-building appurtenant to a dwelling-house, whether attached thereto or not, or a shop or any building not being a public building, or a building of the warehouse class.

"*Dwelling-house*" means a building used or constructed or adopted to be used wholly or principally for human habitation.

"*Masonry-walled building*" means a building the external walls of which are constructed of brick, stone or other similar material, without the aid of timber, iron or steel framing.

"*Frame-building*" means a building the external walls of which are constructed of timber, iron, or steel framing, filled in or wholly or partially covered with brick, stone, iron plates, or other material, and the stability of which depends mainly upon such framing.

"*Open building*" means a shed or other structure consisting of a ground-floor storey covered with a roof erected on posts without any filling between such posts, either of masonry, iron sheets, or any other materials, and no such structure shall be deemed to be the subject of, or referred to, in any of the following bye-laws save where the expression "open building" is used to denote the same.

"*Composite building*" means a building of which part is masonry-walled building, and part is either open building or frame building, or a building of which part is open building and part is of frame building, to each of which classes of building, the bye-laws relating to masonry-walled buildings, open buildings and frame buildings, respectively, shall apply.

"*Chawl*" means a building so constructed as to be suitable for letting in separate tenements, each consisting of a single room, or of two rooms, but not of more than two rooms.

"*Privy on intermediate system*" means a privy the excrementitious matter from which is collected in a suitable receptacle on the ground-floor and flushed therefrom with water at regular fixed intervals by means of an automatically discharging tank fixed at a height of not less than six feet above the receptacle and kept continually supplied with water by means of a separate supply tank.

Water-closet—(*a*) Every water-closet to be separated from any room intended to be used for human habitation by a dead wall, which shall be lined internally to a height of six feet with a smooth impervious non-absorbent coating of neat Portland cement not less than half an inch in thickness, or of glass, glazed tiles or polished marble.

(*b*) Every water-closet should have a window of not less than 3 square feet opening upon an external open space.

(*c*) The entrance to such water-closet should be through a lobby or bath-room having at least one window, or through a gallery which is entirely open to the outer air on one side.

(*d*) A water-closet should not be constructed within a distance of 3 feet from the boundary of the owner's premises, provided that this rule shall not operate to prevent a water-closet being constructed to abut on a street or service passage or open space intended to be permanently reserved as such.

Privy (including in this expression a privy on the intermediate system) :—

(*a*) Every privy should have on each side, except the entrance side, an open space, 3 feet in width, within the owner's own limits and open to the sky.

(*b*) The entrance gallery or communicating bridge should be at least 3 feet in width and open to the external air on both its sides and be shut off from any portion of any dwelling house by a closely fitting door.

(*c*) Every privy should have a window in one at least of the walls, of not less than 3 square feet opening upon an external open space.

(*d*) Every privy should have its walls lined internally with a smooth impervious non-absorbent coating of neat Portland cement or of glass or glazed tiles to a height of not less than 5 feet above the floor of such privy.

Except with the written permission of the Municipal Commissioner, no person shall construct any cellar, vault, or underground room, either under, or as part of a building, or otherwise.

"*Level of plinth*" should not be less than 2 feet above the level of the centre of the adjacent portion of the nearest street.

Paving, &c., of floors and damp-proof courses for walls—

(*a*) Every water-closet, privy, urinal, washing or bathing place and water-room, and every portion of every ground-floor and also—

(*b*) In the case of a chawl—

(*i*) every part of each floor included in such work, and

(*ii*) every communicating passage on an upper floor included in such work, and not being an external verandah,

to be laid or paved with stone, slate, or non-absorbent tiles laid in cement, or with asphalt, cement, koba or other durable material impervious to moisture.

Damp-proof course.—In the case of masonry buildings, the owner shall provide, in each brick wall included in such work, which is below the level of the lowest floor, a *damp-proof course* which shall consist of sheet lead, asphalt, slates laid in cement, vitrified bricks or any other durable materials impervious to moisture.

34. *Construction of Moris*—No wooden beam or joist shall be directly under such *moris*. The *mori* to be of

impervious material and perfectly water-proof and to be sufficiently supported along all its four sides.

37. *Construction of Staircases.*—(*f*) Where the staircase is in a dwelling house, and is not otherwise ventilated, it shall be ventilated at the top by means of a window, or a ventilator or sky-light in the roof.

Provision and maintenance of open space (clause *d*), section 461.

(1) In all buildings intended to be used as a dwelling, the whole of at least one side of every room should abut on an exterior or an interior open space or on an open verandah.

(2) Every such exterior open space shall extend throughout the entire length or depth of the building on the side of which such room so abuts, and shall be maintained for the benefit of such building exclusively, and its minimum width shall be according to the height of such building where it immediately adjoins such open space. In the case of dwellings other than chawls :—

Minimum width of open space throughout should be	*Where height of building above the plinth does not exceed should be*
2 feet	22 feet
3 ,,	33 ,,
4 ,,	44 ,,
5 ,,	55 ,,
6 ,,	66 ,,
7 ,,	where height exceeds 66 ,,

In the case of chawls—

5 feet	22 feet
6 ,,	33 ,,
7 ,,	44 ,,
8 ,,	55 ,,
9 ,,	66 ,,
10 ,,	where height exceeds 66 ,,

(3) Every such interior open space shall have an area equal to $\frac{1}{10}$th of the aggregate floor area of all the rooms abutting thereon, and shall not be less than six feet across in any direction.

(4) Every open space whether exterior or interior shall be completely open to the sky.

(5) No open drain, except for rain water, shall be constructed in such open space.

Provisions as to height, &c., of rooms.

(1) Every room, except a room in the roof, shall be in every part 10 feet in height from the floor to the ceiling.

(2) The room in the roof shall have an average height of 8 feet from the floor to the ceiling, and a minimum height of 4 feet.

(3) Every room shall have a clear superficial area of 100 square feet.

(4) Every such room shall be ventilated by doors and windows opening directly into the external air, and have an aggregate opening equal to not less than $\frac{1}{4}$th of the superficial area of that side of the room which faces an open space.

(5) In back to back rooms and in other single and two room tenements, every such room in addition to other means of ventilation described above, shall have a ventilator of at least 3 square feet in area near the top of the walls of such room, and such ventilators shall be opposite to each other. In case of upper rooms, one such ventilator may be represented by a ridge ventilator or ventilating tiles.

Corridors :—Every corridor in a chawl shall be kept open to the open air at each of its ends. Corridors more than 50 feet in length shall be provided at intervals of 55 feet with an opening on both sides of the corridor 5 feet square communicating wholly with the open air to its full height.

PROVISIONS AFFECTING THE DUTIES OF A SANITARY INSPECTOR.

Under section 68, the Municipal Commissioner empowers any of the Municipal officers to exercise, perform, or discharge, as the case may be, several powers, duties, and functions conferred or imposed upon or vested in the Commissioner by the several sections, clauses and sub-sections of the said Act mentioned hereafter :—

Inspectors and Assistant Inspectors :—Sections 82–253–374–396 (1)–413 (1)–415–422–424 (1)–425 (1)–427 (3)–479 (5)–488.

Sub-Inspectors and Muccadums :—Sections 253–374–396 (1) and 422.

District Registrars :—82–253–374–396(1)–413(1)–415–422–424 (1)–427 (3)–479 (5) and 488.

Sub-Registrars and Nurses :—253–374–422 and 445.

BOMBAY ACT No. II OF 1899.

Sale of Food and Drugs Act, applicable to Ghee only (*Ghee Act*).

The Municipal Commissioner empowers Municipal officers under section 4 (1) to exercise the powers vested in him, by section 4—sub-sections (1) and (2) :—

Whoever sells to the prejudice of the purchaser any article of food, *viz.*, Ghee, which is not of the nature, substance or quality of the article demanded by such purchaser, shall be punished by fine upto Rs. 100 for the first offence and up to Rs. 500 for a second or any subsequent offence.

No offence is deemed to have been committed (*a*) where any matter or ingredient not injurious to health has been added to the article of food, &c.; (*b*) where in the process of production, preparation or conveyance of such article of food some extraneous substance has unavoidably become intermixed therewith ; and (*c*) where any matter or ingredient not injurious to health has been added or mixed with such article of food, and before the sale thereof, the seller has brought to the notice of the purchaser either by a label or otherwise, the fact that such matter or ingredient has been so added or mixed.

N. B.—If in compliance with a demand for Ghee any article is supplied, which contains *any substance not exclusively derived from milk,* such article shall be deemed to have been sold to the prejudice of the purchaser, unless, before the sale thereof, the seller has brought to the notice of the purchaser the fact that it contains such substance.

In case of prosecution, ignorance of the nature, substance or quality of the article sold is no defence.

The vendor, however, shall not be deemed to have committed an offence, if he proves to the satisfaction of the Court that—

(*a*) the article sold was purchased by him as the same in nature, substance and quality as that demanded by the purchaser and with a written warranty to the effect that it was of such nature, substance and quality;

(*b*) that he had no reason to believe at the time when he sold it that the article was not of such nature, &c.; and

(*c*) that he sold it in the same state in which he purchased it.

4–(1) Persons refusing to sell any article to proper authority are liable to penalty.

(2) The officer shall, *after the purchase shall have been completed,* forthwith notify to the seller his intention to have the same analysed by the Chemical Analyser to Government and shall offer to divide the article into 3 parts to be then and there separated and each part to be marked and sealed or fastened up in such manner as its nature will permit, and shall deliver one of the parts to the seller or his agent, retain the second part for future comparison, and submit the third part to the Chemical Analyser to Government for analysis.

N. B.—(The article should be divided into three *equal* parts.

A purchase is said to be *complete* when the article sold is received in our charge and the full *amount* of such article has been *paid to the vendor*.)

If the seller do not accept the offer of the purchaser to divide in his presence the article purchased, the Chemical Analyser to Government receiving the article for analysis shall divide the same into 2 parts and shall seal one of those parts, and deliver the same to the purchaser who will produce it before the Court.

The Chemical Analyser certifies as follows in case of adulterated Ghee :—" that it contains substance or substances not exclusively derived from milk."

A summons must be applied for within 28 days next after the commission of the offence.

Bye-laws made by the Municipal Corporation under section 461 of the Municipal Act of 1888 :

Under clause (*f*).—With respect to the control and supervision of premises used *for offensive trades*, &c., under section 394 of the Act.

1. Written applications to be made by the applicants for licenses.
2. Owners to furnish the names of occupants.
3. License holders to afford facilities for examination of premises.

Premises used for *manufacturing, &c., cloths in indigo or other colours* :—

4. License holders not to store materials not required for immediate use.
5. To adopt the best means of rendering vapours innocuous.
6. To cleanse premises daily.
7. To keep floors, &c., in good repair.

8. To keep drying ground free from hollows, &c.

9. To maintain drainage in good order.

Premises used for *manufacturing, &c., blood, bones, candles, cat-gut, fat, manure, meat offal, oil-cloth, soap and tallow* :—

10. License holders to cause premises to be cleansed daily and cause refuse fragments to be collected and removed.

11. All receptacles to be kept clean.

12. To adopt best means of rendering vapours innocuous.

13. To keep all internal surfaces of walls and floors in good order.

14. To lime-wash the interior twice a year or oftener.

15. To maintain drainage in good order.

16. To maintain ventilation in good order.

17. To adopt and maintain appliances, &c., for preventing nuisance.

18. To adopt and maintain appliances, etc., for preventing nuisance.

19. Buildings used for storing not to be inhabited.

Premises used for *preparing hides or skins* :—

20. Premises to be swept daily, and hair, flesh, &c., to be collected and removed.

21. To cause implements and apparatus to be kept clean.

22. To cause waste lime to be removed from premises with proper precautions.

23. To cause walls to be scraped or otherwise cleansed periodically and interior to be lime-washed.

24. To cause walls and floors to be kept in good repair to prevent absorption of noxious matter.

25. To maintain drainage in good order.

Premises used *for storing or pressing hides or skins* :—

26. To lime-wash the interior periodically.

27. To maintain ventilation in good order.

28. Buildings used for storing not to be inhabited.

29. These do not apply to the storing of properly tanned and dressed leather.

Premises used for *manufacturing, &c., cotton refuse* or *seed, fins, fish, horns, hoofs, hair, rags and wool* :—

30. Premises to be kept thoroughly clean.

31. The interior to be lime-washed periodically.

32. To maintain drainage in good order.

33. To maintain ventilation in good order.

34. To adopt and maintain appliances, &c., for preventing nuisance.

35. Buildings used for storing not to be inhabited.

Premises used for *keeping horses, cattle or other four-footed animals for sale, or hire, or for sale of the produce thereof* :—

36. License-holder to furnish names of all owners of animals stabled.

37. Dung not to be deposited so as to pollute water.

38. *Floors* to be paved so as to prevent soakage.

39. *Receptacles* for dung to be provided. Such receptacles to be constructed with floors not lower than surface of adjoining ground and so constructed as to prevent escape or soakage of contents and should be provided with covers.

40. Paved space should be provided *for washing cattle.*

41. Drainage to be maintained in good order.

42. Premises to be thoroughly *cleansed daily.* (All dung, refuse, &c., should be removed by the license-holders in their own carts to the Tardeo Flats.)

43. *Dimensions*—Stables for horses or cattle shall not be less than 12 feet in height, and, if for one row of animals, the breadth shall be 12 feet (measuring from the outside of the manger to the opposite wall), and for a double row of animals 25 feet (measuring from one manger to the other) if the mangers are placed against the external walls, and 24 feet in breadth (measuring from the external walls) if the mangers are placed in the centre. The space to be allowed to each horse shall be 7 feet in width, and for each bullock, cow or buffalo 3½ feet in breadth.

Under clause (g) *Regulations for construction of new Dairies and Milch Cattle Stables :—*

1. License-holders (in addition to observing preceding bye-laws) to bring out animals for inspection.

2. Water-supply to be provided. Well -water not to be used.

3. (*a*) The building shall be open on all sides (weather protections may be allowed).

   (*b*) The roof shall be tiled or of corrugated iron sheets supported by wooden posts or iron columns.

   (*c*) The floor shall be paved throughout with stone and properly sloped.

4. (*a*) An open space 15 feet in width should be provided all round the stable.

   (*b*) No milch cattle stable should be erected within a distance of 20 feet from any street or passage.

5. Proper drains should be provided as approved by the Drainage Department.

Under clause (h) *Regulations for securing cleanliness of milk shops and milk vessels :—*

1. Milk not to be sold in dwelling houses, &c.
2. Internal surfaces of walls and ceilings of every room in which milk is kept or sold to be limewashed periodically.

3. Milk vessels to be rinsed and thoroughly cleansed before and after use.
4. Water from Municipal mains and approved wells only to be used for washing milk vessels.

Under clause (j) *Precautions against any contagious or infectious disease* :—

1. Immediate notice to be given of any outbreak of sickness, and sick animals to be segregated.
2. Sickness in a Municipal milch cattle stable should be reported in the first instance to Ramoshi in charge.
3. Milk of diseased animals not to be sold or used for domestic purposes.
4. No person suffering from dangerous or infectious disease to be permitted to sell or distribute milk.
5. No person engaged in sale or distribution of milk to come in contact or communication with diseased persons.

Under clause (p) *Bye-laws for regulating and maintaining all places for disposal of dead* :—

1. No grave shall be re-opened for another interment within 12 months, when the body of a person has been buried without coffin.
2. In case of burial in *unlined wooden coffin,* no grave shall be re-opened for another interment within 18 months.
3. In case of burial in a *coffin composed of or lined with tin,* lead or other metal, no grave shall be re-opened for another interment within a period of 7 days.
5. *Regulations for graves* :—
    (*a*) All graves be made in regular lines.
    (*b*) All graves should be properly filled in, &c.
6. All places for the disposal of the dead shall be kept clean and in good order.

7. No person shall retain a corpse on any premises, without burning, burying, or otherwise lawfully disposing of the same, for more than 24 hours.

8. Corpses for *removal to Kerbela* :—

(*a*) No such corpse shall be retained on any premises other than a registered place of burial.

(*b*) No such corpse shall be retained for more than two months without Municipal Commissioner's sanction.

(*c*) Every such corpse shall be enclosed in a suitable dammered box, soldered metal case, coffin, or other covering so as not to cause any nuisance, &c.

9. Coffins intended to be removed by sea or rail shall be protected by an outer casing or cover so as to guard against damage in transit.

10. No such coffin shall be removed except under a certificate of the Health Officer stating that such coffin is in a fit state to be removed.

11. In Municipal Burning and Burial grounds fees shall be charged according to the scale fixed.

Bye-laws relating to Markets.

11. No person shall bring any dog, or knowingly permit any dog to follow him, into any Municipal Market.

SANITARY ADMINISTRATION OF A PORT.

The Port Health Authority consists of a Port Health Officer, appointed and paid by Government, and his assistants, whose duties are to carry out the inspection of shipping entering and leaving the harbour, and the disnfection of ships and crews.

In exercise of the powers conferred by section 6, subsection (1), clause (*p*), of the Indian Ports Act, 1908, as amended by the Indian Ports (*Amendment*) Act, *IV of* 1911, the......................is pleased to make the following regulations in respect of the following diseases: (1) *Small-pox*, (2) *Chicken-pox*, (3) *Measles*, (4) *Plague*, (5) *Cholera*

(6) *Yellow Fever,* (7) *Sleeping Sickness and* (8) *Jigger,* occurring on vessels coming to or leaving ports in
,or for the time being in port in
and in respect of any death on a vessel not carrying a *medical officer* coming to or leaving port in
or for the time being in port in

PART I.—DEFINITIONS.

1. In these regulations

(1) "Health Officer" means any person appointed by the local Government, either by name or by virtue of his office, to be Health Officer of a port, and includes any officer appointed by the local Government either by name or by virtue of his office, to perform any of the duties of a Health Officer of a port;

(2) "healthy vessel" means a vessel,

(*a*) which, even though coming from an infected port, has not had on board any death from unknown or suspicious cause, or any patient suffering, or suspected to be suffering, from any of the diseases enumerated in the preamble, either *at the time of* departure, during the voyage from the last port of call, or on arrival; and,

Paris Co
tion, articl

(*b*) which has not, within a period of twelve, or in the case of plague five, days, immediately preceding her arrival, left an infected port or communicated (except orally without contact or by signal) with a vessel which has left an infected port within that period;

(3) "infected vessel" means a vessel which has on board one or more cases of any of the diseases enumerated in the preamble, or on board of which a case *or suspected case* of any of those diseases has occurred *within* the twelve days (in the case of plague seven days) immediately preceding her arrival at a port in British India,or on which rats have died from plague *within the last mentioned period*;

Paris Co
tion, articl

(4) the term "infected," when used with reference to any articles, means articles which the local Government may, by notification in the local official Gazette, declare to be infected with any of the diseases in question.

ris Conven-
, article 20.

(5) the term "infected port," when used with reference to a port in British India, means any port which the local Government may, by notification in the local official Gazette, declare to be infected

(6) "suspected vessel" means a vessel on board of which there has been a case of any of the diseases enumerated in the preamble at the time of departure or during the voyage from the last port of call, but on board of which no fresh case or suspected case of such disease has occurred *within* twelve days (in the case of plague seven days) immediately preceding her arrival, or on which unusual mortality among rats *not definitely known to be plague* has been observed, or which has, *within a period of twelve, or in the case of plague five, days immediately preceding her arrival, left an infected port or communicated* (*except orally without contact or by signal*) *either with a vessel which has left an infected port within that period or with an infected vessel*;

(7) "master," when used with reference to a vessel, means any person (except a pilot or harbour master) having for the time being charge or control of the vessel;

(8) "Port Officer" includes any person, acting under the authority of the local Government, in charge of port discipline.

PART II.—VESSELS ARRIVING AT PORTS IN BRITISH INDIA.

2. The master of every *suspected or infected* vessel, arriving at any port in British India, shall hoist a signal which shall be—

by day Flag L of the Commercial Code, which is a square flag of yellow and black borne quarterly, and *by night* three lights, at a height of not less than 20 feet above the hull of the ship, which shall be arranged at a distance of not less than six feet apart, in the form of an equilateral triangle, and of which the light at the apex of the triangle shall be white and the lights at the ends of the base shall be red,

and shall report every such case or death that may have occurred from any of the causes enumerated above, or in the case of a vessel not carrying a *medical officer* any death from any cause, to the pilot or other boarding officer at the earliest opportunity, and shall also comply, on arrival at such place, as may be appointed in this behalf by the local Government, with such regulations as may be made by the local Government in regard to—

(*i*) signalling the name of the port from which the vessel has come,

(*ii*) stopping at a particular place,

(*iii*) refraining from communication with the shore, and

(*iv*) taking measures for giving effect to the present regulations.

3. If the vessel be at anchor within port limits when such disease first breaks out or such death occurs, the master shall hoist the signals specified in rule 2.

4. The pilot or other boarding officer shall promptly report the circumstances of the case to the Port Officer, who shall immediately forward any report so made, or give notice of any signal hoisted, to the Port Health Officer.

5. (1) When any *healthy* vessel carrying a *medical officer* is within sight of a port in Britsh India, the master may intimate the fact by signal.

(2) Such intimation shall ordinarily be accepted by the Port Officer; and if so accepted, the Health Officer need not visit the vessel, which may be given pratique at once.

(3) *Any healthy vessel not carrying a medical officer shall be considered a suspected vessel for the purposes of regulation 2.*

PART III.—BERTHING OF VESSELS.

6. (*a*) If the number of deaths from or cases of the diseases enumerated in the preamble, with the exception of plague and yellow fever, does not exceed two, the vessel will not be prohibited from taking up the usual place of anchorage in the harbour or port, except that she may not enter the docks without the written permission of the Health Officer, and the passengers and crew not suspected of having any of the diseases in question need not, except in the case of pilgrim and emigrant ships *and those not carrying a medical officer,* be detained on board pending the inspection of the Health Officer. The master of the vessel shall be responsible that no one of the passengers or crew, except those referred to above, is allowed to leave the vessel before inspection by the Health Officer, and shall prevent the landing of infected bedding, clothes, or other personal effects which he has reasonable cause to consider likely to be infected.

(*b*) If the number of cases or deaths within the previous twelve days has exceeded two, or when from their occurrence on pilgrim or emigrant ships or for other special reasons further precautions may be deemed advisable, the pilot, or in his absence the master, shall keep hoisted by day or night as the case may be, the signals prescribed by regulation 3, and shall anchor the vessel in the place appointed for the purpose and shall not allow any of the passengers or crew to leave the vessel until pratique is granted.

7. If a case of yellow fever or of plague or unusual mortality among rats has occurred on board, the vessel shall not take up the usual place of anchorage pending the visit of the Health Officer; in the meanwhile the vessel shall stop at such place as the local Government may by order provide.

8. So long as the signals prescribed by regulation 3 are shown, no *tindal* or other person in charge of or navigating any boat shall, without the permission of the Health Officer, attempt to take it alongside such vessel.

PART IV.— INSPECTION OF VESSELS.

9. Whenever the Health Officer receives the notice referred to in regulation 4, he shall without unnecessary

delay proceed on board and examine the vessel, and the master shall give him every facility for the examination of the passengers, crew, personal effects, cargo, and any part of the ship the Health Officer thinks necessary. The Health Officer may require a declaration on oath from the medical officer (if any) of the vessel or from the master or from both, whether any death or sickness from an unknown or suspicious cause, or any case of any of the diseases enumerated in the preamble, has occurred on board the vessel either during the voyage or before her departure, and with reference to plague, whether any unusual mortality has been observed among rats. If the Health Officer is satisfied that such deaths as may have occurred were not due to any of the causes enumerated in the preamble, he shall permit the vessel to proceed to anchorage and to discharge passengers and cargo, without any further restrictions. If he is not so satisfied, he shall proceed as provided in these regulations. The inspection by the Health Officer will ordinarily take place between sunrise and sunset.

10. As a result of every inspection the Health Officer shall classify the vessel as infected, suspected or healthy, *in accordance with the definitions given in Part I.*

11. On the completion of the inspection prescribed by regulation 9, such of the passengers and crew as *have been detained under regulation* 6 (*a*) *but who* are found to be free from any of the diseases in question and unlikely to carry infection shall be allowed to land. All baggage, personal effects and cargo, except such articles as the Health Officer is entitled to disinfect, may also be landed.

12. If a case of any of the diseases enumerated in the preamble occurs on any vessel after she has entered dock or has been moored at a wharf, the master shall forthwith cause information thereof to be given to the Dock Master or Superintendent of the Wharf, who shall communicate the information to the Health Officer (through the Port Officer) and to the Superintendent of Police, and shall be responsible that the sick person shall be isolated as much as possible, and that free communication with the wharf is stopped until the Health Officer has inspected the vessel.

PART V.—REMOVAL OF THE SICK.

13. When on inspection the Health Officer considers it necessary in order to prevent the spread of disease, he shall take the measures indicated in Part VI of these rules as the case may be.

14. *Except as provided for under regulation* 19 (2), the removal of *sick* passengers is not to be enforced in the case of persons bound for an onward port unless under the clearest necessity, and in every such case a special report explaining the reasons for the action taken must be submitted by the Health Officer to the local Government.

15. The Port Health Officer shall inform the Municipal Health Officer in all cases in which he arranges for the conveyance of a patient to a sanitarium or hospital or other place within municipal limits, and shall furnish the Municipal Health Officer with the address of any private residence to which he permits the removal of a patient.

16. Where small-pox is the disease on account of which the vessel is deemed to be infected, the Health Officer shall offer, without charge, vaccination or re-vaccination to all persons willing to be operated upon, and shall cause to be vaccinated, if their guardians or those in charge of them consent, all children below 10 years and over 6 months of age who do not bear marks of vaccination or of small-pox. In the case of plague, inoculation may similarly be offered free of charge to all willing to be inoculated.

PART VI.—MEASURES TO BE TAKEN IN THE CASE OF HEALTHY, INFECTED AND SUSPECTED VESSELS.

17. Vessels classed by the Health Officer after inspection as healthy shall be given free pratique.

PART VI.-A.—SMALL-POX, CHICKEN-POX, MEASLES AND CHOLERA.

18. In the event of a vessel being classed either as infected or suspected on account of any of the above-mentioned diseases, the Health Officer

(1) shall not enforce the removal from the vessel of any person or persons bound for an onward port,

unless under the clearest necessity as provided for in regulation 14;

(2) may arrange for the conveyance of any person suffering or suspected to be suffering from such disease to a sanitarium or hospital, unless the sick person or his friends can make adequate provision elsewhere of which the Health Officer must satisfy himself;

(3) shall either himself undertake, or direct the master of the vessel to undertake, the destruction or disinfection of all clothing, bedding and other articles of personal use which have been used by any person suffering from any of the above-mentioned diseases, and are or are likely to have been soiled with infective matter or to retain infection;

(4) may, when a vessel with one or more of the above-mentioned diseases on board has passengers or crew in a filthy and unwholesome condition, cause the clothing and personal effects of such persons to be disinfected before allowing them to leave the vessel;

(5) may, in the case of undecked craft, direct the disinfection, or in special cases the destruction, of foodstuffs which have been exposed to contamination and are considered likely to be infected;

(6) may direct the disinfection and cleansing of any portion of the vessel that has actually been exposed to contamination or is in a filthy or insanitary condition, and may prohibit the discharge of bilge water or water ballast within port limits;

(7) may, in the case of cholera, direct the master to have the bilges and water tanks emptied and cleaned outside port limits.

PART VI-B—PLAGUE.

19. In the case of infected vessels the following measures shall be taken :—

Paris Con
tion, article

(1) All persons on board shall be medically examined as prescribed in regulation 9.

(2) All persons suffering from plague shall immediately be disembarked under the directions of the Health Officer and isolated in the camp or hospital, whether ashore or afloat, appointed by the local Government for the purpose.

(3) *If the port of arrival is free of plague*, other persons shall also be disembarked, if possible, and shall either be kept under observation* during a period which shall not exceed five days dating from the arrival of the ship and which may or may not be followed by surveillance* of not more than five days' duration or may, at the discretion of the Health Officer, be subjected to surveillance only during a period which shall not exceed ten days.

(4) The Health Officer may permit such healthy members of the crew as are required to be present on board for the care and safety of the vessel, to remain on board but subject to surveillance. Such persons shall not land, without the permission of the Health Officer, until pratique is given.

(5) Such soiled linen, wearing apparel and articles belonging to the crew and passengers as are, in the opinion of the Health Officer, infected shall be disinfected.

(6) All parts of the vessel which have been occupied or frequented by plague patients shall be disinfected; and any other parts of the vessel that, in the opinion of the Health Officer, are infected, shall be disinfected.

(7) The rats on board shall be destroyed, either before or after discharge of the cargo, in either case as quickly as possible, and in any case within a maximum time of forty-eight hours in such manner as

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* "Observation" means isolation either on board the ship or in a sanitary station appointed for the purpose before the grant of pratique. Passengers under "surveillance" are not isolated; they receive pratique at once and are at liberty to proceed to their destinations, but the authorities at those places are informed of their coming and they are subjected to medical examination for such period as may be fixed in these rules.

to avoid damage to merchandise and to the ship's plating and engines. In the case of ships in ballast this process must be carried out as soon as possible before embarking cargo.

(8) Passengers arriving by an infected ship are entitled to obtain from the Health Officer a certificate showing the date of their arrival and the measures taken as regards themselves and their baggage.

Paris Convention, article 33.

20. When the measures prescribed in regulation 19 have been duly taken in respect of any vessel, the Health Officer shall by written order grant pratique, provided that, if a case of plague or of illness suspected to be plague occurs on board subsequent to the grant of the above certificate, the certificate shall become invalid and the vessel again become subject to the requirements of the regulations regarding infected vessels.

21. In the case of suspected vessels the following measures shall be taken:—

Paris Convention, article 22.

(1) All persons on board shall be medically examined as prescribed in regulation 9.

(2) The crew and passengers may at the discretion of the Health Officer be subject to surveillance, the duration of which dating from the arrival of the ship shall not exceed five days. The crew may also during that period (or, if the vessel is in port for less than five days, during the time she remains in port) be prevented from leaving the ship, except on duty on such conditions as the Health Officer may consider permissible.

(3) The destruction of rats may be ordered at the discretion of the Health Officer, and if ordered shall be carried out in the terms of regulation 19 (7).

(4) All soiled linen, wearing apparel and personal effects of the crew and passengers which are or are suspected to be infected, shall be disinfected.

(5) All parts of the vessel which have been occupied or frequented by plague patients shall be disinfected; and any other parts of the vessel that, in the

opinion of the Health Officer, are infected, shall be disinfected.

22. When the measures prescribed in regulation 21 have been taken in respect of any vessel, the Health Officer shall by written order, grant pratique.

Paris Convention, articles 23-24.

23. In the case of healthy vessels pratique shall ordinarily be given at once as provided for in regulation 17, but the Health Officer may in his discretion, if special circumstances appear to him to require it, impose any or all of the following measures:—

(1) medical examination as prescribed in regulation 9;

(2) disinfection of soiled linen, etc., as prescribed in regulation 19 (5);

(3) destruction of rats as prescribed in regulation 19 (7); but the process of deratisation must not occupy more than 24 hours;

(4) he may also subject the passengers and crew to surveillance for a period not exceeding five days from the date of departure from the infected port.

Paris Convention, articles 29-30.

24. In exercise of the functions imposed upon him by regulations 9, 19 and 21, the Health Officer shall—

(*a*) attach due importance to the presence on board the vessel of a medical officer and to the provision of apparatus for disinfection by means of saturated steam and for the destruction of rats, and

(*b*) shall take into account the sanitary or insanitary, and roomy or crowded condition of the vessels.

25. If, in the case of any vessel making a passing call, the communication with the shore is restricted to the landing of passengers, mails or goods, the Health Officer may, in his discretion, enforce the provisions of regulation 19, 21, or 23, as the case may be, to such extent only as may in his opinion be necessary for the purpose of controlling the actual communication with the shore.

Provided (*a*) that any persons on board the vessel whom the Health Officer has reason to believe to be suffering from plague shall be landed and kept under observation.

Paris Convention, article 32.

Provided also (*b*) that ships from an infected place that have been disinfected and have undergone adequate sanitary measures, shall not, on their arrival in another port, be subjected to these measures a second time if no case has occurred since the disinfection was performed and if they have not called at an infected port. A ship which has merely disembarked passengers and their baggage or mails, without having been in communication with the shore, shall not be regarded as having called at the port.

Paris Convention, article 25.

26. The Health Officer shall whenever requested furnish the master, the ship-owner or the ship-owner's agent, with a certificate stating that measures of rat destruction have been carried out and giving the reasons why they were resorted to.

27. The foregoing regulations shall not prevent the transhipment, under restrictions to be imposed by the Health Officer in conformity therewith, of passengers, mails or goods between vessels which have not been granted pratique.

28. If any case of plague occurs among any group of persons who are being kept under observation, the patient shall be isolated or sent to a hospital, and the other persons shall continue to be detailed and segregated as aforesaid for a period not exceeding five days from the date on which the group became free from plague. The clothes and effects of the patients and of such persons as have been in contact with the patient shall be disinfected at the discretion of the medical officer in charge.

29. The medical officer in charge of any place appointed for the isolation of any persons under these regulations may, in his discretion, by written order, direct that any person who is kept there under observation shall be allowed to depart and shall be subject to surveillance.

30. If the system of surveillance to which any person is subjected on shore requires his daily attendance before a medical officer, the Health Officer may, by written order, exempt such person from such attendance on being satisfied that he may be relied upon to send in a prompt report if he should fall sick.

31. Persons subjected to surveillance shall submit to, and comply with, all directions as to medical supervision or otherwise, which may be given by written order of a medical officer appointed by the local Government in this behalf.

PART VI-C.—YELLOW FEVER.

32. In the case of vessels which have started from or touched *en route* at a port infected with yellow fever the following procedure shall be observed:—

Paris Convention, article 182.

(1) The vessel shall be anchored at sea not less than a mile from the land at low water. The visit of the Health Officer shall be made during the day as early as possible.

(2) Any person suffering from yellow fever, if in the first four days of the disease, or if there is any doubt about the duration of the disease, shall be protected from the approach of mosquitoes by means of curtains, and if possible, the sick should be treated on board for at least four days. All passengers in perfect health (with normal temperature, etc.,) may be landed, special precautions being taken to prevent mosquitoes having access to them, and shall be kept in quarantine for seventeen days in mosquito-proof houses.

(3) If it is necessary to land the sick, the most minute precautions to prevent mosquitoes reaching them shall be taken, including a mosquito-proof cabin on the launch, mosquito-proof ambulances and a mosquito-proof ward in an isolation hospital.

(4) The crew of the vessel should be required to sleep in airy places, preferably on deck, and should be protected by mosquito curtains.

(5) The ship shall be cleared of mosquitoes by the systematic fumigation,* under efficient supervision, of every cabin, store-room, alley-way and hold.

(6) All water in which mosquitoes could breed should be emptied into the sea and all drains flushed by

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* Sulphurous acid is probably the best gas to use.

means of a hose. The bilge should be pumped out or oiled. The drinking water tanks should be pumped out or oiled. The drinking water tanks should be emptied to get rid of larvæ, fresh water being taken and the tanks completely filled so as to drown any adult mosquitoes which may be present in them.

(7) Provided, if no case of yellow fever has occurred during the voyage, only such of the above measures shall be carried out as are considered by the Port Health Officer necessary in the circumstances of the case.

(8) No ship shall leave the anchorage for the purpose of taking up her berth until the measures described in paragraphs (5) and (6) have been carried out.

PART VI-D.—SLEEPING SICKNESS.

33. In the case of a vessel having on board a person suffering, or suspected to be suffering, from sleeping sickness, the person or persons shall not be permitted to land without the specific written permission of the Health Officer, *who* may, pending the receipt of written instructions from the local Government, permit the landing of such persons only if arrangements can be made for their strict isolation on shore.

Note.—In suspicious cases the Health Officer should make a careful examination for enlargement of the lymphatic glands, particularly those in the triangles of the neck. The pulse rate should also be taken. To confirm the diagnosis gland-juice should be taken and examined for the presence of try-panosomes.

34. *In the case of a vessel arriving from the East Coast of Africa within the limits of Port Sudan and Durban or from other localities declared to be infected, the procedure prescribed by rule* 2 *shall be complied with and the crew or passengers, etc., shall be medically inspected in accordance with rule* 9.

PART VI-E.—JIGGER.

35. In the case of a vessel having on board any person or persons suffering from jigger,

(1) the Health Officer shall carefully examine every person on board and any person or persons found to be suffering may be removed to hospital for treatment ;

(2) the clothes of infected persons shall be disinfected, and the Health Officer may, in his discretion, order the disinfection of the clothes, bedding, etc., of all persons on board ;

(3) any part of the vessel likely to harbour jigger fleas shall be thoroughly washed with a watery solution of kerosine oil emulsion ;

(4) the ballast of such vessel, if of earth or sand, shall not be landed without the permission, in writing, of the Health Officer, who, if he considers it necessary, may order that it shall be discharged into the $\frac{\text{sea}}{\text{river}}$ at such places as shall be appointed for the purpose by the local Government.

PART VII.—GENERAL.

Vessels.

36. The master of any vessel coming under these regulations shall comply with all directions which the Health Officer may consider necessary under the foregoing rules.

37. The master of any vessel who may object to submit to the foregoing regulations may put out to sea again, provided that objection has been taken before there has been any communication, except by signal or through the port authorities, between such vessel and the shore or with any other vessel in port. Goods may be landed from such vessels after precautions have been taken to isolate the ship, crew and passengers and on condition that such information as the Health Officer may require regarding the mortality among rats is duly supplied : Passengers may be

disembarked at their own request on condition that they submit to all the measures prescribed by the local authorities.

38. In the event of any vessel putting back to sea the Health Officer shall intimate the fact by telegraph to the next port of call.

Persons.

39. All persons removed to hospital or kept under observation at any place shall obey and conform to the rules, regulations and orders for the time being in force at such hospital or place and shall be liable to pay all such charges for food as for the time being may, under the sanction of the local Government, be made against them.

40. When a suspected case of any infectious disease is removed from a vessel at an Indian port, the Health Officer shall report the confirmation or otherwise of the diagnosis, by telegraph, to the Health Officer of the next port of call, if that port is in British India, Ceylon or the Straits Settlements. In other cases a note shall be made on the bill of health stating the nature of the suspected infectious disease and the precautions taken in connection therewith.

Dead Bodies.

41. Disposal shall be as follows :—

(1) If death occurs on board a vessel before entering port limits, the body shall, except there are special reasons to the contrary, be buried at sea in not less than nine fathoms of water, in such manner as shall secure its immediate sinking and remaining below the surface.

(2) If death occurs during the day on board a vessel within the port limits the ensign and house flag, if there is one, are to be immediately lowered half-mast and kept in such position from sunrise till sunset as long as the body remains on board. If death occurs between sunset and sunrise, one red light is to be hoisted at the peak, half-mast high.

(3) The master of the vessel shall cause the death of a person on board to be intimated forthwith to the police, either by letter or otherwise, and shall forward to the Port Officer a written report as soon as possible after the occurrence, in which all the circumstances attending the death must be fully detailed.

(4) No dead body shall be removed from a vessel within port limits without the permission of the police, which shall not be given until the Health Officer has certified *either*—

(a) *that the death is not due to infectious disease ; or*

(b) *that, in the case of infectious disease, the Port authorities have given permission for burial on shore.*

If the Port authorities, in consultation with the Health Officer, decide that burial on shore cannot be permitted, the body must be buried at sea in such manner as the Health Officer may direct.

Disinfection on Ships.

42. All disinfection prescribed by these regulations shall be carried out, unless otherwise specifically provided for, in the manner prescribed in the Appendix hereto.

PART VIII.—VESSELS LEAVING PORTS IN BRITSH INDIA DECLARED BY THE PORT BOARD OF HEALTH TO BE INFECTED WITH ANY CONTAGIOUS OR INFECTIOUS DISEASE, FOR PORTS BEYOND INDIA.

43. No vessel shall leave any port in British India *which has been declared to be infected with any contagious or infectious disease* for any port *in or* beyond India until—

Paris Convention, article 46.

(1) all persons sailing by the vessel, whether as passengers or as members of the crew, have been medically examined by the Health Officer.

(2) in the case of plague—

Paris Convention, article 46.

(*i*) all persons sailing by the vessel, either as passengers or as members of the crew (except onward bound passengers who have not landed and members of the crew, *who have not landed or* who have not newly joined, who may be examined on board), have been medically examined by the Health Officer on shore by day as shortly as possible before embarkation ;

(*ii*) all merchandise or articles of any sort which the Health Officer may consider to be infected with plague have been disinfected on shore previous to embarkation ;

Paris Convention, article 47.

(*iii*) all clothing, bedding and infected articles belonging to Asiatic and African members of the crew, not being officers, engineers or doctors, to deck and fourth class passengers and to third class passengers not entitled to cabin accommodation, which the Health Officer may consider to be infected with plague, and if the Health Officer thinks fit so to direct all clothing, bedding and infected articles belonging to passengers of any class higher than the third and of any members of the crew, have been disinfected on shore by day as shortly as possible before being placed on board ;

(3) the Health Officer has given to the master of the vessel a bill of health stating that the medical examination and disinfection prescribed by this regulation have been carried out.

In the case of any disease other than plague, the Health Officer may, in his discretion, enforce the provisions of clauses 2 (*ii*) and 2 (*iii*) above.

Provided that, if the vessel is only making a call at the British Indian port in question, the medical examination and disinfection prescribed by this regulation shall be made only in the case of persons joining the vessel there and articles belonging to them, unless there is communication between the vessel and the shore. The Health Officer shall decide, for the purpose of this proviso, what constitutes communication between the vessel and the shore.

44. It shall be open to the Consular representative interested in any vessel to be present, if he so desires, at

the medical examination and disinfection prescribed by regulation 43.

45. If any vessel does not leave port *within 24 hours after* the medical examination made under regulation 43, she shall not leave until—

(*a*) a fresh medical examination of the passengers and crew has been made under that regulation, and

(*b*) a fresh bill of health has been given to the master under that regulation.

Provided that such fresh examination may be conducted on board the vessel, whether or not there has been communication with the shore since the previous examination was made.

46. If, after a bill of health has been given to the master of any vessel and before the vessel leaves the port, any cargo or goods of any kind be placed on or taken off the vessel *except in such manner as may be directed by the Health Officer,* the vessel shall not leave the port until—

(*a*) such further medical examination and disinfection as the Health Officer may consider necessary have been made under regulation 43, and

(*b*) a fresh bill of health has been given to the master under that regulation.

Provided that such further examination and disinfection may be conducted on board the vessel.

47. (1) After a bill of health has been given to the master of any vessel no person except the pilot *or person authorised by the Health Officer* shall be permitted to embark on the vessel unless he has been medically examined by the Health Officer as prescribed in regulation 43.

(2) If any such person is permitted to embark, the Health Officer shall amend the bill of health accordingly.

48. Port-clearance shall not be granted for any vessel, unless and until the master produces the bill of health prescribed by the foregoing regulations.

Provided that at any port where, in the opinion of the local Government, local conditions render this relaxation advisable, the Port Officer may grant port-clearance for any vessel on receiving from the agents of the vessel a written guarantee that a duplicate of such bill of health, signed by the Health Officer, will be furnished by them to him within forty-eight hours.

49. (1) If the Health Officer considers that any passenger is suffering from, or is in the incubation stage of, any infectious or contagious disease, he shall prevent such passenger and his or her relatives and attendants from embarking or sailing; and their baggage and personal effects shall not be allowed on board the vessel and, if already placed on board, shall be removed as early as possible.

(2) For the purposes of this regulation, the term "relatives" shall mean such persons as have been living with, or have been, in the opinion of the Health Officer, in dangerous communication with the suspected passengers.

50. (1) If the Health Officer considers that any member of the crew of the vessel is suffering from, or is suspected to be in the incubation stage of, any infectious or contagious disease—

(*a*) he shall prevent such member from re-embarking on such vessel and shall refuse to give a bill of health until the baggage and personal effects of such member have been removed from the vessel and such parts of the vessel as have been occupied or frequented by such member have been disinfected; and

(*b*) the baggage and personal effects of such persons as were in immediate contact with such member of the crew shall be disinfected, and the names of such persons shall be given to the medical officer or master of the vessel for supervision on the voyage.

(2) All action taken under clause (1) of this regulation for the disinfection of a vessel shall be noted in the bill of health.

51. Any person who is prevented by the Health Officer under the foregoing regulations from embarking or sailing may be removed to and kept at a hospital or kept under

observation; or, if any such person gives a genuine address, he may, at the discretion of the Health Officer, be subjected to surveillance for a period not exceeding twelve days.

Paris Convention, article 47. 52. At all ports declared to be infected with plague proper measures shall be taken to prevent rats obtaining access to vessels (Appendix B).

Paris Convention, article 34. 53. Regulations 43 to 52 may, by order of the local Government, be applied to vessels leaving a port in India for another in India or Burma.

(*See Regulation* 42.)

APPENDIX A.

INSTRUCTIONS FOR DISINFECTION ON SHIPS.

Paris Convention, article 177 (note). 1. Personal effects, such as rags, bandages, papers and other articles without value, which, in the opinion of the Health Officer, are deemed likely to carry infection should be destroyed by fire.

2. Underclothing, bedding, wearing apparel, mattresses, carpets, etc., which are contaminated or *suspected*, and other articles to be disinfected, should be exposed for 15 minutes to saturated steam—under pressure if possible—at a temperature of not less than 100° C. (212° F.), care being taken that the steam shall reach all parts of each article to be disinfected.

3. *Disinfecting Solutions*—

(*a*) Solution of corrosive sublimate of 1 part in 1,000 with the addition of 2 parts in 1,000 of hydrochloric acid or 160 grains of chloride of soda in one gallon. The solution should be coloured with aniline dye or indigo: it should not be placed in metal vessels.

(*b*) A 5 per cent. solution of pure crystallized carbolic acid, or 5 per cent. of crude commercial carbolic acid free from tar oils in a warm solution of soft soap.

(*c*) Freshly prepared lime-wash.*

4. *Special instructions to be observed in the employment of disinfecting solution.*—The linen, clothing and articles soiled by the excreta of patients should be soaked in the solution of corrosive sublimate. The solution of pure carbolic acid and the solution of soap and carbolic acid are equally suited to the purpose. The articles should remain in the solution for at least six hours.

Articles which cannot be subjected to the temperature of 212° F. without injury, as leather goods, wooden articles stuck together with glue, felt, velvet, silk, etc., should be washed with a disinfecting solution; coins can be disinfected with the solution of soap and carbolic acid. Persons engaged in nursing the sick should wash their hands and faces with one of the carbolic solutions. The carbolic solutions will be useful more particularly for disinfecting articles such as metal or instruments, which can neither be subjected to a temperature of 212° F. nor placed in contact with corrosive sublimate. Slaked lime is particularly recommended for disinfecting excreta. Expectorated matter should be burnt.

5. *Disinfection of ships on which plague has occurred among human beings or rats.*—All rats on board shall be destroyed by means of sulphurous anhydride. The cabins, etc., occupied by the sick or those suspected to be suffering from plague shall, at the discretion of the Health Officer, be treated with a solution of corrosive sublimate and thoroughly cleansed with soap and water. In the case of pneumonic plague preliminary disinfection with corrosive sublimate solution shall be invariably carried out.

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* The lime-wash should contain 20 per cent. of lime, and may be prepared as follows:—Take 2 pounds of good quick-lime and slake it by moistening it gradually with about half a pint of water. When the operation is completed, the resulting powder must be kept in an airtight vessel in a dry place.

For use the quantity of slaked lime obtained from 2 pounds of quick-lime should be placed in a convenient vessel and water added to make one gallon.

6. *Disinfection of the hold of an infected ship.*—The bilge-water shall be pumped out, and the hold washed with sea-water, a sufficient quantity of a solution of corrosive sublimate being subsequently thrown in at the discretion of the Health Officer. The bilge-water shall not be pumped out when the vessel is in harbour without the written consent of the Health Officer.

APPENDIX B.

MEASURES TO BE ADOPTED TO PREVENT RATS OBTAINING ACCESS TO VESSELS.

1. There shall be a space of at least three feet between any part of the vessel and the wall of the dock or wharf.

2. All ropes and hawsers connecting the vessel with the dock or wharf shall be furnished with a circular concave convex rat-guard at least four feet in diameter fitting tightly, with the concavity towards the wharf, on the rope or hawser, and so fixed that no part of the margin of the guard shall be less than 24 inches from the rope or hawser.

3. To prevent rats reaching the ship by means of a gangway as few gangways shall be used as possible; all gangways shall be raised at night; and a watchman shall be placed on each gangway during the day from the time the gangway is lowered until it is raised.

4. A responsible person shall be deputed by the local Government to ensure these measures being applied immediately the vessel is berthed.

CHAPTER II.

COLLECTION, REMOVAL AND DISPOSAL OF TOWN REFUSE.

Bombay Municipal Act, Calcutta Municipal Act, Madras Municipal Act and the District Municipal Act.

Commissioner to provide for cleansing of streets and removal of refuse.

S. 365. For the purpose of securing efficient scavengering and cleansing of all streets and premises, the Commissioner, Chairman, President or Chief Officer shall take measures for securing—

(*a*) the daily surface cleansing of all streets in the City, and the removal of the sweepings therefrom;

(*b*) the removal of the contents of all receptacles and depôts and of the accumulations at all places provided or appointed by him under section 367 or 368, for the temporary deposit of any of the matters specified in the said sections.

Refuse, &c., to be the property of the Corporation.

S. 366. All matters collected by Municipal servants or contractors in pursuance of the last preceding section and of section 369 shall be the property of the Corporation.

Provision and appointment of receptacles, depôts and places for refuse, &c.

S. 367. (1) The Commissioner shall provide or appoint in proper and convenient situations public receptacles, depôts and places for the temporary deposit or final disposal of—

(*a*) dust, ashes, refuse and rubbish;

(*b*) carcasses of dead animals and excrementitious and polluted matter:

(2) Provided that—

(*c*) the said matters shall not be finally disposed of in any place or manner in which the same have not heretofore been so disposed of, without the sanction of the Corporation, or in any place or manner which Government think fit to disallow;

(*d*) any power conferred by this section shall be exercised in such manner as to create the least practicable nuisance.

Duty of occupiers to collect and deposit dust, &c.

S. 368. (1) It shall be incumbent on the occupiers of all premises to cause all dust, ashes, refuse and rubbish to be collected from their respective premises and to be deposited at such times as the Commissioner, by public notice, from time to time prescribes, in the public receptacle, depôt or place provided or appointed, under clause (*a*) of the last preceding section, for the temporary deposit thereof:

(2) Provided that the Commissioner may, if he thinks fit, by written notice, require the occupier or owner of any land, to cause all dust, ashes, refuse and rubbish to be collected daily, or otherwise periodically, from the said land and from any building standing thereon and deposited temporarily upon any place forming a part of the said land which the Commissioner appoints in this behalf, and it shall be incumbent on the said occupier to cause the said matters to be collected and deposited accordingly.

Provision may be made by Commissioner for collection, &c., of excrementitious and polluted matter.

S. 369. When the Commissioner has given public notice, under clause (*a*) of section 142, of his intention to provide in a certain portion of the City, for the collection, removal and disposal, by municipal agency, of all excrementitious and polluted matter, from privies, urinals and cesspools, it shall be lawful for the Commissioner to take measures for the daily collection, removal and disposal of such matter from all premises situate in the said portion of the City.

Collection and removal of excrementitious & polluted matter, when to be provided for by occupiers.

S. 370. It shall be incumbent on the occupier of any premises situate in any portion of the City for which the Commissioner has not given a public notice under clause (*a*) of section 142 and in which there is not a water-closet or privy connected with a municipal drain, to cause all excrementitious and polluted matter accumulating upon his premises, to be collected and to be conveyed to the nearest receptacle or depôt provided for the purpose under clause (*b*) of section 367, at such times, in such vehicle or vessel, by such route and with such precautions, as the Commissioner, by public notice, from time to time prescribes.

Halalkhors' duties in certain cases may not be discharged by private individuals without the Commissioner's permission.

S. 371. In any portion of the City in which the Commissioner has given a public notice under clause (*a*) of section 142, and in any premises, wherever situate, in which there is a water-closet or privy connected with a municipal drain, it shall not be lawful, except with the written permission of the Commissioner, for any person, who is not employed by or on behalf of the Commissioner, to discharge any of the duties of halalkhors.

Prohibition of failure to remove refuse, &c., when bound to do so.

S. 372. No person—

(*a*) who is bound, under section 368 or section 370 to cause the removal of dust, ashes, refuse and rubbish, or of excrementitious or polluted matter, shall allow the same to accumulate on his premises for more than twenty-four hours, or neglect to cause the same to be removed to the depôt, receptacle or place provided or appointed for the purpose;

Removal of refuse, &c., contrary to orders or without proper precautions.

(*b*) shall remove any dust, ashes, refuse or rubbish or any excrementitious or polluted matter, otherwise than in conformity with the requirements of any public or written notice at the time being in force under section 368, or use for the removal of any excrementitious or polluted matter any vehicle or vessel not having a covering proper for preventing the escape of any portion of the contents thereof, or of the stench therefrom;

Failure to clear away any refuse, etc., which drops during removal.

(*c*) shall whilst engaged in the removal of any dust, ashes, refuse or rubbish or of any excrementitious or polluted matter, fail forthwith thoroughly to sweep and cleanse the spot in any street upon which during removal, any portion thereof may fall, and entirely to remove the sweepings;

Leaving filth carts, etc., unnecessarily in the streets.

(*d*) shall place or set down in any street any vehicle or vessel for the removal of excrementitious or polluted matter, or suffer the same to remain in any street for any greater length of time than is reasonably necessary.

Throwing or placing refuse, etc., in any place not assigned for the purpose.

(*e*) shall throw or place any dust, ashes, refuse or rubbish, or any excrementitious or polluted matter, on any street, or in any place not provided or appointed for this purpose under section 367 or 368;

Allowing filthy matter to flow or soak from any premises, & keeping any thing thereupon so as to create a nuisance.

(*f*) who is the owner or occupier of any building or land, shall allow any filthy matter to flow, soak or be thrown therefrom, or keep or suffer to be kept therein or thereupon, anything so as to be a nuisance to any person, or negligently suffer any privy-receptacle or other receptacle or place for the deposit of filthy matter or rubbish on his premises to be in such a state as to be offensive or injurious to health.

Presumption as to offender under clause (*e*) of section 372.

S. 373. If it shall in any case be shown that dust, ashes, refuse or rubbish, or any excrementitious or polluted matter, has or have been thrown or placed on any street or place, in contravention of clause (*e*) of the last preceding section from some building or land, it shall be presumed, until the contrary is proved, that the said offence has been committed by the occupier of the said building or land.

The cleansing of a city forms the basis of all health reforms and devolves on the Sanitary Authority.

The term 'sewage' means all excrementitious and polluted matter capable of being removed by drains and sewers, in a liquid or semi-liquid state.

'House refuse' is defined in the London Public Health Act, 1891, as consisting of ashes, cinders, breeze and night-soil filth, but does not include trade refuse.

In India, the term 'household and street refuse' includes all waste material from houses and shops which cannot be removed by drains, and includes very little cow manure but large quantities of horse stable manure and refuse, and bullock dropping, street sweepings and gully refuse, leaves, garden refuse, fruit and vegetables, old glass, tin and much paper, dead animals, &c.

In India decomposition is so rapid, and flies and other insects so numerous, that decomposing matter is more dangerous than in temperate and cold climate.

Diarrhœa, Dysentery, Cholera, Enteric are much more liable to be spread by flies conveying the germs from infected refuse.

'Trade refuse' means the refuse of any trade, manufacture or business or of any building materials.

It is always necessary to collect and convey refuse some distance, and as a rule transhipment of the refuse from carts to Railway waggons is necessary, and then again another unloading. All this is expensive and dangerous to health.

COMPOSITION OF ENGLISH AND INDIAN REFUSE.

HOUSEHOLD AND STREET REFUSE.

Various methods are adopted in cities and towns in India for the collection and removal of refuse. The actual method varies somewhat. Bullock carts are the usual form of motor power, while in Calcutta horses are used. Steam and petrol wagons are being adopted in Bombay; the refuse thus collected is carried to Railway sidings and then hauled outside the Island and used for reclaiming land. In Calcutta and Madras some of the refuse is thus disposed of and part of it is incinerated, in other places mixed with night-soil.

In London the house refuse amounts to 1¼ million tons per annum, 4—5 cwts. per head per annum, but is much heavier, bulk for bulk, than Indian refuse.

BOMBAY.

The amount of this refuse in Bombay which includes all household waste, stable manure from private stables, road sweepings, shop sweepings and office paper and garden refuse works out to 2.2 lbs. per day per head of the population, or .36 of a ton per annum, about 7 cwts. per head per annum.

This does not include dung from milch cattle stables during the dry months, as this is used for cow-dung cakes.

In tropical climates this refuse decomposes much more rapidly than in more temperate countries, especially in the rains and it is thus necessary that the storage of refuse should not be allowed but that it should be removed twice a day at least.

This entails a large outlay, both in manual labour and vehicular plant, more supervision and a larger staff, as much depends on the rapidity and thoroughness with which the work is done.

The habits of the people in throwing all waste matter into the streets tend to make the work of cleaning the City more difficult, while their customs and modes of cooking and cleaning utensils increase the amount of household refuse.

Indian refuse or *cutchra* contains very little coal or cinders, and is largely composed of stable bedding, horse dung, and vegetable refuse, mixed with street sweepings, kitchen refuse, old glass, metals, &c.

COMPARISON OF AN AVERAGE SAMPLE OF A LARGE INDIAN CITY'S REFUSE WITH THAT OF LONDON REFUSE.

Refuse of Indian City.		*Refuse of London.*	
1. Hay	.. 42.4	1. Cinders and ashes	.. 63.69
2. Waste Paper	.. 21.2	2. Dust	.. 19.51
3. Dry leaves, *bidees*, &c.	.. 14.3	3. Vegetable, animal and various mineral matters	.. 4.61
4. Vegetable matter (green)	.. 8.2	4. Waste paper	.. 4.28
5. Dung	.. 4.6	5. Straw, &c.	.. 3.22
6. Drain stuff	.. 4.0	6. Bottles	.. .99

Refuse of Indian City.

7.	Dust	3.0
8.	Straw	1.5
9.	Ashes	1.5
10.	Garden Clippings	1.0
11.	Offal, fish refuse, &c.	.9
12.	Glass	.6
13.	Green leaves, grass, &c.	.6
14.	Cotton waste	.3
15.	Tins	.2
16.	Rags	.1
17.	Cinders	.4
18.	Broken Crockery	.1
19.	Bones	.1
	Total	100.0

Refuse of London.

7.	Coal and Coke	.84
8.	Tins	.79
9.	Crockery	.55
10.	Bones	.48
11.	Broken glass	.47
12.	Rags	.39
13.	Iron	.21
	Total	100·0

During the monsoon it is generally very wet, and soft wet vegetable refuse lies so close that air cannot penetrate it to support combustion, and unless special means, devised for the nature of the fuel it contains, are employed to burn it, no satisfactory results may reasonably be expected.

COLLECTION AND REMOVAL OF REFUSE.

The practice of depositing refuse and waste material on the roadside or foot-path is common in most cities.

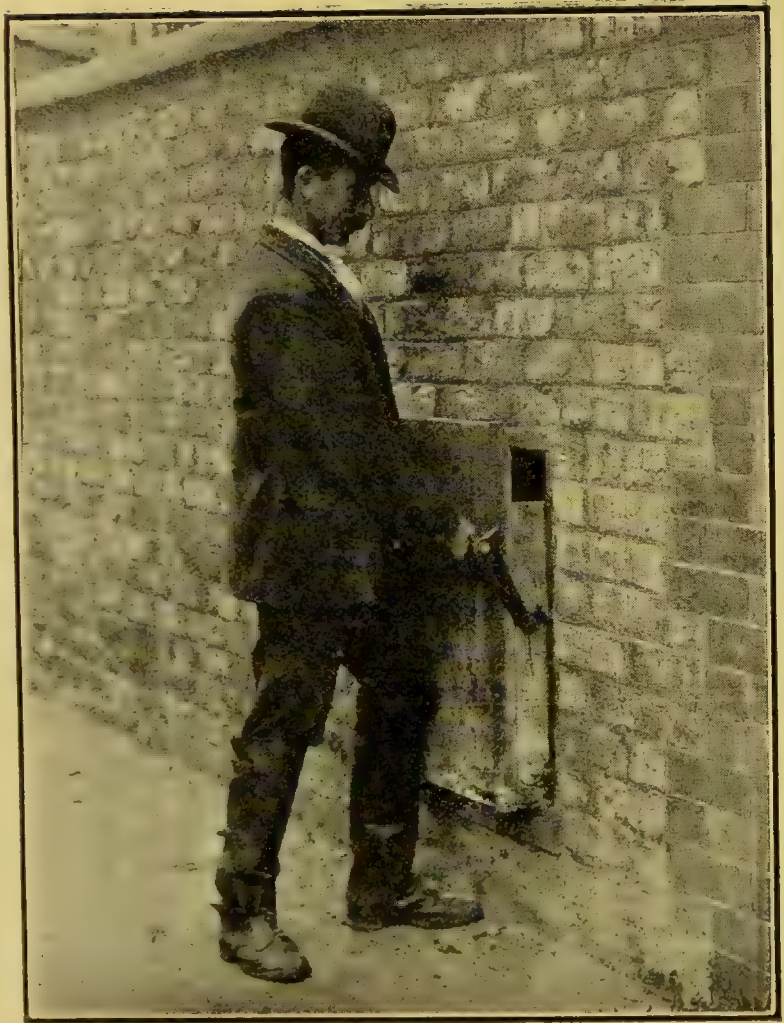
This is to be avoided by providing Sanitary bins into which the refuse should be deposited and which should be emptied by travelling-carts twice a day.

All refuse carts should be covered so that when full there will be no nuisance as they proceed along the streets.

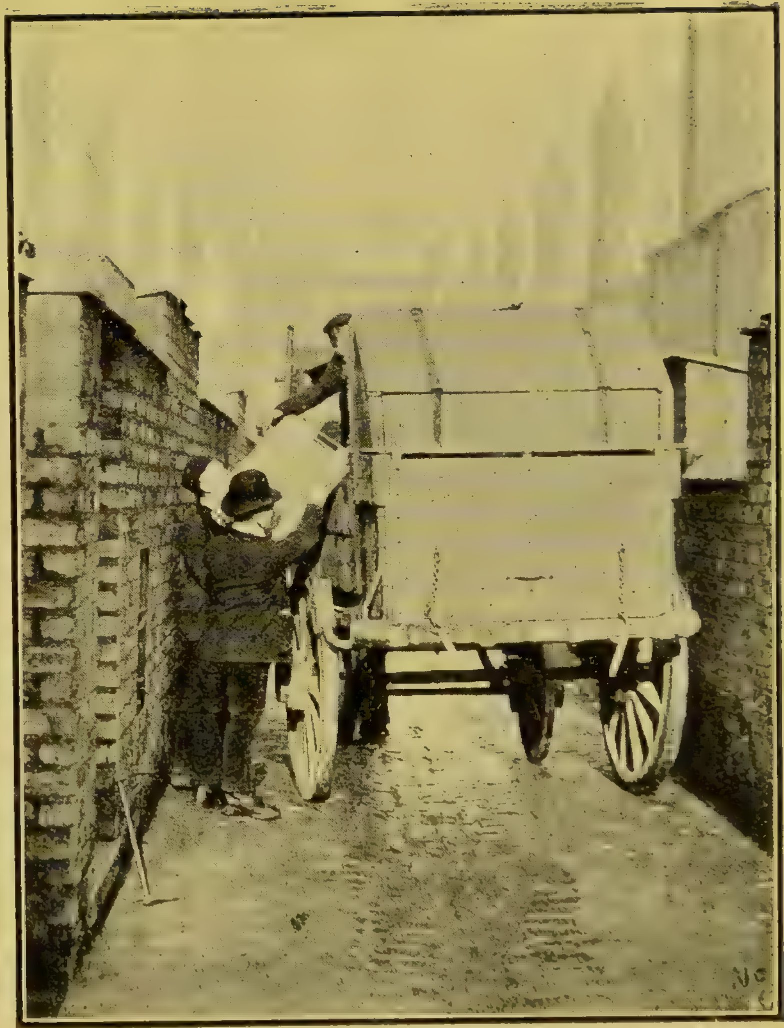
The refuse thus collected can be taken either direct to the Incinerator or to the Railway siding or reclamation ground. In the latter case the siding should be so arranged that the carts can tip directly into the wagons.

A Railway wagon holds 12 to 15 tons of refuse.

The maximum amount of work a pair of bullocks well-fed can do in a day is to travel 20 miles and draw a load of



Removing an Ashbin, London.



Dust-bin Cart, London.

8 cwts. in a 2-wheeled or 16 cwts. in a 4-wheeled cart on a level and good road. This means loaded one way and empty for the return, and no detention for loading, *i. e.*, on return with an empty cart they should be yoked to a cart loaded ready for removal. If the cart has to go from place to place collecting refuse, the number of trips that it makes will be less than if working with a duplicate cart. A cubic yard of house refuse in India weighs about 8 cwts. to 10 cwts.

In Bombay the life of a bullock may be taken as 5 years; the cost of haulage of this household and street refuse by bullocks is :—

		Rs.
(*a*)	Cost of a pair of bullocks	150
(*b*)	Feed of a pair of bullocks @ Rs. 20 per mensem for 5 years, 20×12×5	1,200
(*c*)	Shoeing and veterinary treatment for a pair @ Rs. 3 per mensem=3×12×5	180
(*d*)	A cart costs Rs. 250, and by taking the total number of carts scavengering and drain, it works out to about one duplicate cart to each cart ; then each pair of bullocks has 2 carts, hence	500
(*e*)	Repairs to (*d*) for 5 years	300
(*f*)	Stabling accommodation for (*a*) and (*d*) 15 p.c. of 300	45
(*g*)	A cart-driver's pay is now Rs. 11 per mensem but deducting absentees will make the average.	650
(*h*)	Accommodation for cart-driver at 10 p.c...	65

The total then is Rs. 3,090 for 5 years, and during this period a pair of bullocks removes 2,190 tons, the cost of removal being Rs. 1-6-7 per ton.

As many as 2,300 carts are now unloaded at the siding in Bombay daily :—

Cost of unloading carts at the siding, loading wagons and haulage and unloading of the same calculated on an average of 2,200 *cart loads per day :—*

114 men at Rs. 11 per mensem each and 24 women at Rs. 7½ each per mensem, 2 Muccadums at Rs. 15 each

per mensem, 2 trip markers at Rs. 20 each per mensem and an Inspector on Rs. 150 per mensem = Rs. 1,654 or say, roughly Rs. 1,650.

The number of trips made to the siding daily is about 2,200, *i.e.*, 880 tons, 26,400 tons per mensem, and to unload this costs Rs. 1,650, or anna one per ton.

The haulage from siding to reclamation ground costs Rs. 3¼ per wagon, unloading costs Rs. 1-14-0 per wagon, and as an average of 32 carts or 14 tons go to a wagon, 1 ton costs for hauling and unloading.—

	Rs.	a.	p.
	0	5	10
For up-keep of permanent-way ..	0	1	2
Per ton ..	0	7	0

The up-keep of a wagon costs Rs. 100 per annum and as a wagon carries roughly 14 tons and makes a trip a day, and one on every alternate Sunday (340 a year),

340×14=4,760 tons a year.

	Rs.	a.	p
The cost of up-keep per ton is then	0	0	4
Summary of cost per ton :—			
Removal from section to siding	1	6	7
Unloading at siding	0	1	0
Haulage to reclamation ground and unloading there	0	7	0
Up-keep of rolling stock	0	0	4
Rs. ..	1	14	11
Supervision on Rs. 1-14-11	0	4	7
Total Rs. ..	2	3	6
Total cost per ton Rs. ..	2	3	6

FEED OF BULLOCKS.

Ooreed and moongh belong to the same class as grass, *viz.*, the bean tribe. The following is their composition, which will show their nutritive value to be almost exactly alike, if anything moongh is richer in nitrogenous matter than ooreed :—

	Ooreed.	*Moongh.*
Water	11·00	9·20
Nitrogenous matter	22·48	24·70
Fatty matter	1·46	1·48
Carbohydrates	62·15	60·36
Salts	2·91	3·26

Both of these form the food of cattle in parts of India.

	Gram.	*Bran.*	*Ooreed.*
Water	10·80	13·6	11· 0
Proteids	19·32	13·6	22·48
Fat	4·56	3·4	1·46
Carbohydrates	62·20	54·9	62·15
Salts	3·12	5·6	2·91

As a food, bran by itself is useless in spite of its chemical composition, but as a useful adjunct to other foods it is undeniably valuable. Both gram and bran contain a larger proportion of fat than ooreed and in the majority of dietaries fat finds a place, and when hard work is to be done an excess of fat is invariably taken. Hence gram and bran forms a more nutritious food for cattle than ooreed alone.

The cost of feeding bullocks varies with the kind and price of food and the districts, size of bullocks, &c.

In Bombay a pair of bullocks gets 10 lbs. gram soaked in water and the water drawn off, 1 lb. bran mixed with the gram, and 30 lbs. of hay daily.

Bombay produces about 960 tons of refuse daily (exclusive of milch cattle dung) or 365 tons per annum per 1,000 of the population or 2.21 lb. per head per day or .36 ton per head per annum, against 250 tons per 1,000 of the population of large English towns or 1.52 lbs. per head per day or ·25 ton per head per annum.

The amount of house refuse to be removed is much less in English cities than in India, as a great part is burnt in kitchen fires in European towns, and the labour is more easily controlled than in Indian cities.

The household refuse is removed once or twice a week in English towns, while in India it should be collected twice a day, and the dust bin carts removed twice and three times a day.

In English towns large refuse carts capable of carrying one ton are drawn by horses and accompanied by two men, pass through the streets and visit houses in rotation, weekly visits being made to each house.

The household refuse is collected and taken to the nearest depôt, which is rarely a mile away, and is either burnt or put into barges and taken down the river or canal and then disposed of.

In some towns, London and Liverpool especially, motor vans are used.

In India, we cannot immediately reduce the amount of refuse to be removed, nor can we reduce the number of times we remove the refuse; but by adopting the most cleanly and expeditious method of removal known, we can abate the nuisance.

The custom in Indian towns, where no compounds exist, is for the household and trade refuse from shops, &c., to be thrown into the streets and narrow passages between the houses. They are swept and the garbage collected twice and thrice daily, deposited in the dust bin carts and removed as often as the magnitude of the staff and the strictness of supervision permit.

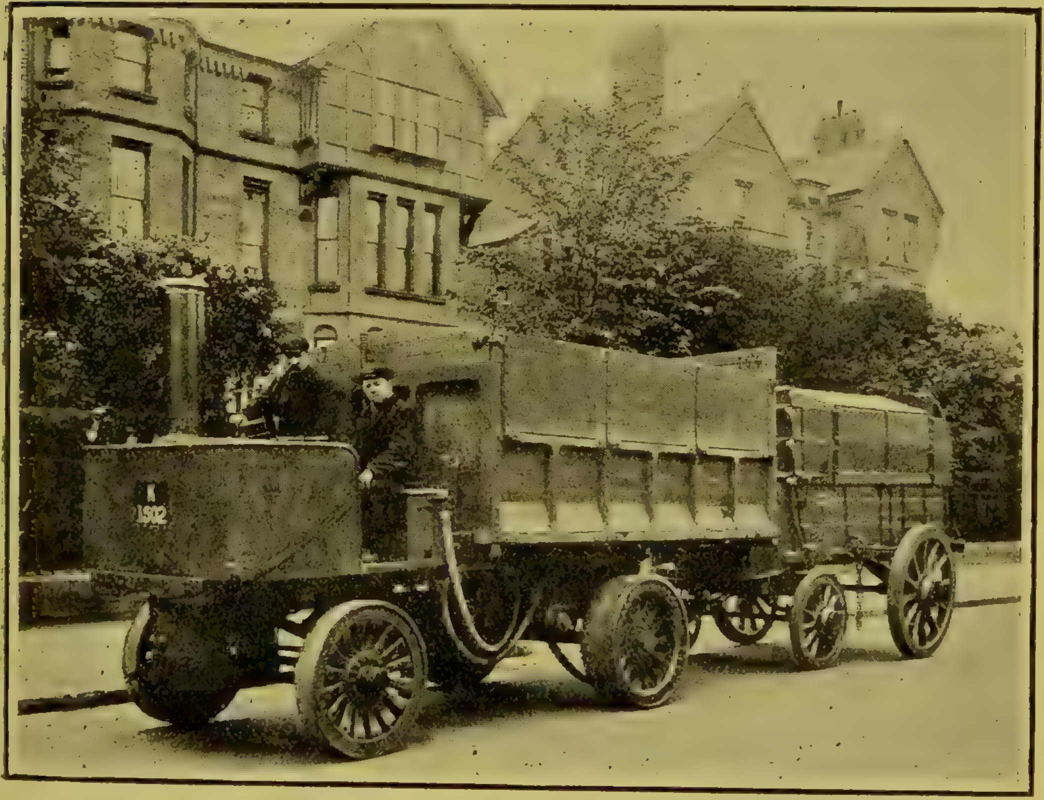
Sanitary dust bins should be provided and emptied twice daily by the labour staff of the Health Department, or contractors, either into travelling carts or motor vans or the nearest standing cart.

Large carts and horses as are used in England would be an improvement, but very expensive and difficult to manage in the East. Some large carts, however, to act as emergency carts, can with advantage be adopted.

MOTOR VANS.

Motor vans are used in many of the large towns for various purposes, and in Liverpool and London and Bombay and many other cities for Municipal work.

These motors work day and night, in the day time collecting house and street refuse and in the night watering and sweeping the streets by means of a movable body, the body of the cart being removed and replaced by a water tank.



REFUSE REMOVAL, LONDON.

During the past few years, the use of motors for Municipal work has rapidly developed.

Motors are used in many of the Metropolitan Boroughs of London, Westminster, Chelsea, and the City, Acton, Burnley, Liverpool, Bradford, Blackburn, Glasgow, Norwich, Bournemouth, &c.

Description of street cleansing in the City of London.

"Street cleansing in the City of London" refers only to that part of London known as the City, or about a 10th of the whole of London. The City contains nearly 48½ lineal miles of streets, courts, alleys and bridges within an area equal to only one square mile, and it is estimated that 1,250,000 persons and over 1,000,000 vehicles enter and leave the City daily and that more than 380,000 persons are engaged during the day within it.

Of the 48½ miles of streets, about 37 miles have both foot-ways and carriage-ways, the remainder being foot-ways only.

The carriage-ways are paved as follows:—Asphalte 225,722 super yards, wood blocks 175,856 super yards, and are paved with 83,421 super yards of asphalte and 245,187 super yards of York stone.

The rateable value of the City is £5,373,276.

For cleansing purposes the City is divided into 4 districts, each having its own Divisional and Boys' Foreman, with a District Staff of carmen, sweepers, orderly boys, horses and vans.

Night Cleansing.—The work of cleansing the main thoroughfares begins at 8 p.m.; the night section numbers 91 men classified as follows:—

2	District Foremen.	1	Flushing Foreman.
18	Flushers.	4	Sweeping Gangers.
43	Sweepers.	12	Carmen.
6	Motor Drivers.	5	Assistant Motor Drivers.

The men work from 8 p.m. until 6-30 a. m. the following morning, except on Saturday and Sunday nights, when the hours are from 12 midnight until 9 a.m., 1½ hours being allowed for meals. During these hours practically the whole of the City is cleaned or washed by water from hydrants, or water van with jet and hose, and by hand broom, squeegee, and rotary brush.

The men commence in the main streets, where the traffic ceases after 7 p.m., paying particular attention to the streets in the immediate vicinity of markets, where business is resumed at an early hour in the morning.

Some two hours before midnight the men commence to prepare the streets, where the traffic continues running until a late hour, by lightly watering so as to loosen the accumulation of mud, horse dropping and grease; these are then followed by the rotary brushes, which sweep the dirt to the sides of the roadway, leaving it to be heaped and picked up. Since the advent of the motor omnibus considerable additional work has been entailed in keeping the streets in a proper state of cleanliness, owing to the large quantity of oil deposited upon the surface of the carriage ways. When flushed or washed, the water runs off the surface without penetrating or affecting the greasy mud, so causing the pavement to dry very slowly and rendering gravelling very necessary.

In addition to the night cleansing, the main streets and bridges, leading to the various markets, are regularly gravelled to avoid, as far as possible, any loss of time in the produce arriving at its destination through bad travelling.

On Sunday at midnight, flushers are engaged with jet and hose, flushing main streets and courts, particular attention being given to those which receive more than an ordinary share of refuse.

In the winter months, when there is a possibility of frost, every care is taken in the use of water and frequently street washing and flushing is entirely suspended.

The quantity of water used during 1907 for washing and flushing streets, courts and alleys, was 77,424,000 gallons at a cost of £1,935-0-0, the number of nights when it was used being 303.

The actual cost of flushing, wood and asphalte paving is:—

Asphalte $\frac{1}{45}$th of a penny per application; wood $\frac{1}{44}$th of a penny per application; equal in both cases to 7d. per super yard per annum of 6 nights per week.

Day Cleansing.—The outdoor section consists of 450 men and boys, classified as follows:—

4 District Foremen.
13 Sweeper Gangers.
16 Dusting Gangers.
6 Motor Drivers.
4 Boys' Foremen.
132 Sweepers.
71 Carmen.
6 Assistant Drivers.
198 Street Orderly Boys.

The day section commences work at 6 a.m. and finishes at 4-30 p.m. except on Fridays and Saturdays, when they finish at 4 p.m. Each man is allowed 1½ hours daily for meals.

During the first two hours a few men are engaged in sweeping side streets, courts and alleys left uncleansed by the night men, others are engaged on the main streets until 7-30 a.m.

At 8 a.m. the carmen and scavengers commence to clear the house refuse from the kerbs of the streets, named by the Commissioner of Police, from which refuse must be removed by 10 a.m.

The particular work requires every available horse, van and man owing to the limited time given for removal.

Galvanized iron skeps are sold at cost price to house holders requiring them.

At 7-30 a.m. the street orderly boys, who have been previously supplied with hot coffee at their respective depôts, assist in cleansing all the main streets and several of the secondary streets and spread sand or shingle as required.

During wet weather they also squeege the foot-ways and assist the sweepers on the carriage-ways until 5 p.m. in the summer months and 4-30 p.m. in the winter.

From 10 a.m. to 4-30 p.m. the day sweepers are engaged in keeping the main and most of the secondary streets in a state of cleanliness by hand broom during dry weather and by squeeging the carriage-ways during wet weather, many streets being squeeged four or five times daily.

Frequently the streets are not sufficiently wet for squeeging but are in a greasy or pasty condition, caused by intermittent rain or damp and foggy weather; in that case the roadways are watered by water van and squeeged immediately afterwards.

Up to 7-30 p.m. in summer and 7 p.m. in winter, about 50 boys, assisted by a few sweepers, are kept at work on the main streets only. On Sundays a few men and boys are engaged in the main streets from 11 a.m. to 7 p.m. clearing up litter, spreading grit or squeeging as required. Water vans are also out on Sundays during the summer months from 10 a.m. to 4 p.m.

On Bank Holidays, Christmas Day and Good Friday, a number of men and boys are engaged on the main streets.

From June to September inclusive, the street gullies, numbering 2,650, are disinfected once a week. Special court flushing is carried out from June to September, some courts being flushed six times weekly. The quantity of water used for street watering in 1907 amounted to 9,221,000 gallons at a cost of £230-10-6; for flushing sewers, 2,068,000 gallons at a cost of £51-14-0, and from metered hydrants 3,619,000 gallons at a cost of £90-9-6.

Removal of Refuse.—It is estimated that there are nearly 27,800 houses and premises in the City of London, banks, hotels and large public buildings, counting as one building only.

All house and trade refuse, street sweepings and slop are taken to Letts Wharf, Commercial Road, Lambeth.

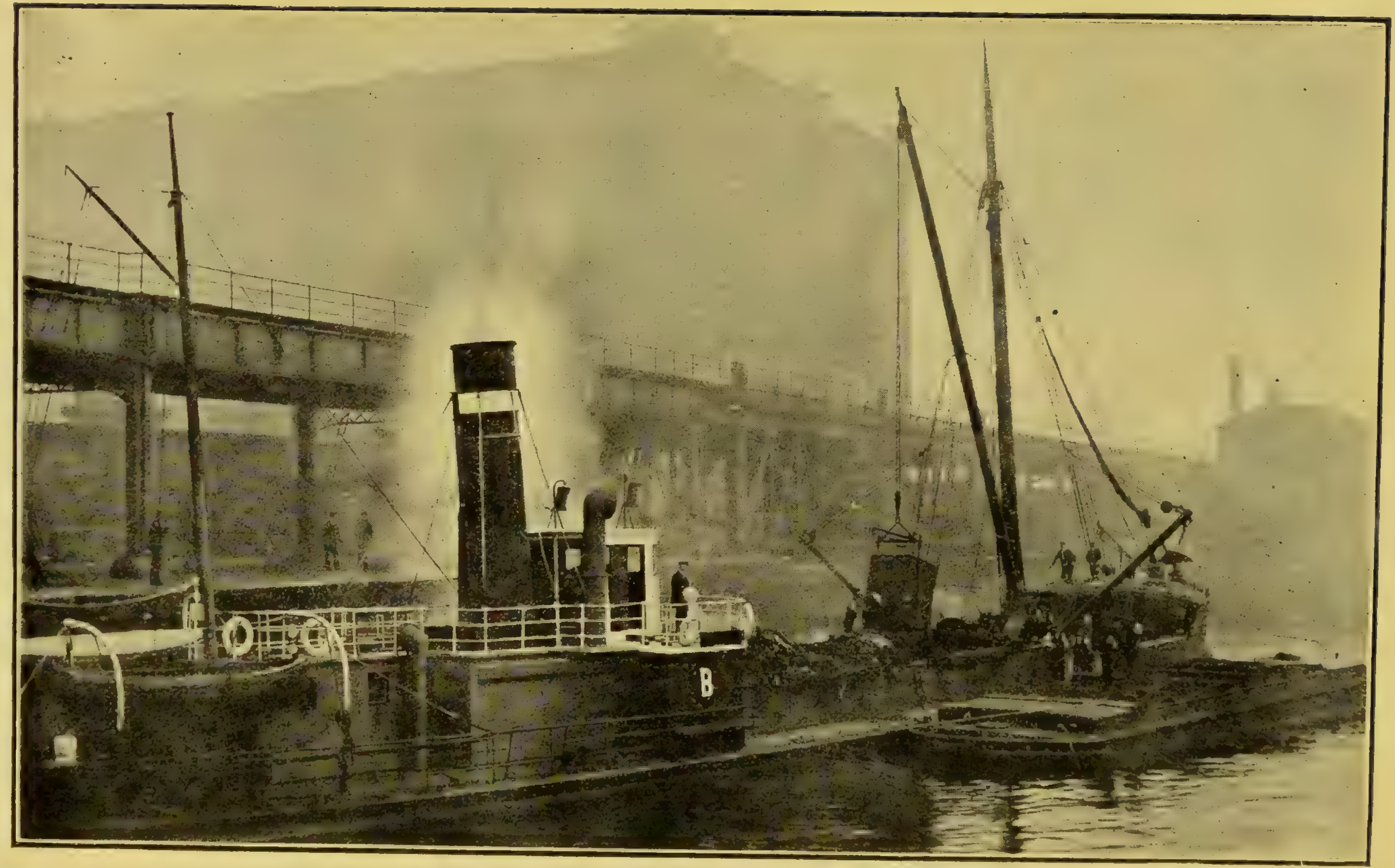
The wharf has a frontage of about 395 feet.

There is one jetty and dock, with berths for seven barges.

The building comprises stabling for 91 horses, cart sheds, workshops, granaries, stores, offices for staff and dwelling houses for the Manager and Foreman Horsekeeper.

All orderly bin manure, old metal and clean waste paper is sold. Sacks for waste paper are provided free.

The charge for removing trade refuse is 7s. 6d. per load.



Barge for Street Refuse, London.

The bulk of the refuse removed in 1907 amounted to:—51,077 van loads taken from premises, 31,977 van loads of street sweepings and slop: Total 83,054 van loads or 270½ loads per working day having a capacity of 4½ cubic yards per load, and weighing 74,490 tons. Of the total quantity of refuse 17,065 tons of manure and street sweepings were sold to, and removed by, contractors.

Sewer Cleansing.—The Cleansing Department is responsible for the cleanliness of all sewers; the total length of the sewers is about 40½ miles, with 205 sewer entrances and 64 flushing gates and about 14,000 inlets from house drains.

Each sewer is cleaned at least once a month. The men employed on this work number 12 with a foreman.

The hours are 41½ per week.

Underground conveniences.—The underground conveniences are under the control of the Cleansing Superintendent. They number 42, of which 29 are for men and 13 for women.

Street Orderly Bins.—393 street orderly bins are distributed throughout the City, each having a capacity of 5⅓ cubic feet for street refuse, and from 1 to 2 cubic feet for sand or shingle. There are also 25 larger bins, with a capacity of 15¾ cubic feet for refuse and 6¾ cubic feet for sand, &c.

Motor Vans.—The Corporation have 6 steam motor vans which cost from £600 to £737 each. These have a capacity of 10 cubic yards, and remove on an average 40 tons of refuse each per week. The wear and tear of boilers, gear and tyres is considerable, and the cost of up-keep averages £133 per annum each van.

Cost of Street Cleansing, &c., 1907.—The total cost in 1907 for street cleansing and removal of house and trade refuse, sweepings and slop, and works in connection therewith, amounted to £63,686. This refers to that part of London known as the City, or about 1-10th of the whole of London, and a day population of 300,000, and a night population of about 20,000.

In a report of the Superintendent of Cleansing, Borough of Chelsea, London, where there are 16 motors at work, collecting refuse, he says : " Motor vehicles have many advantages, but the chief is, no doubt, the speed at which they can work."

Sometime ago an investigation was made by the Borough Engineer of Chelsea. There were then motor vans in use by the following Municipalities :—

Liverpool.
Burnley.
Blackburn.
Bradford.
Glasgow.
Douglas, Isle-of-Man.
Norwich.
Acton.
Bournemouth.
Bootle.

Since then, however, many more motor vehicles have been built and adopted—in Liverpool there are 16, in Chelsea 16 ; Westminster and the City of London have also increased their number. The cost is much less than formerly and many motor vans have been in use for over six years and are still working satisfactorily.

Bombay.

In Bombay the refuse is collected in each Ward from (*a*) streets and roads, (*b*) gullies, and (*c*) compounds.

The sweeping, collecting and removal and disposal is done by the Health Department.

Take A Ward in Bombay as a type of an Anglo-Indian city, which is equal to a small town in England. The total length of streets and roads is about 28·50 miles ; they are swept twice daily and the more frequented and important streets oftener, so that not less than about 57 miles are attended to in a day's work.

The population is 112,838.

There are 507 gullies or passages between houses, with a total length of 4·80 miles ; they are also attended to twice daily, making 9·60 miles of gullies swept daily.

The total amount of refuse collected and removed daily from this section, which consists chiefly of dung, stable, kitchen and office refuse, is about 300 cart loads, and weighs about 120 tons.

The staff employed to sweep this refuse and cart it away is :—

Cart Drivers	81
Begaries	301
Women	168
Pairs of bullocks ..	107½ (includes sick and spare).
Orderly boys	25

This does not include absentees and persons engaged in filling wagons and motors, and report bearers.

The actual staff is as follows :—

Cart Drivers (proper) ..	81	Orderly boys	25
Begaries	287	Stable Muccadum ..	1
Women	168	Muccadums	10
Pairs of bullocks.. ..	105	Patels.	3

It will be seen that each begari therefore has to sweep about 330 yards of road and 52 yards of gullies in a day.

Each begari man and woman, or a gang of men have a beat told off and they attend to this portion only.

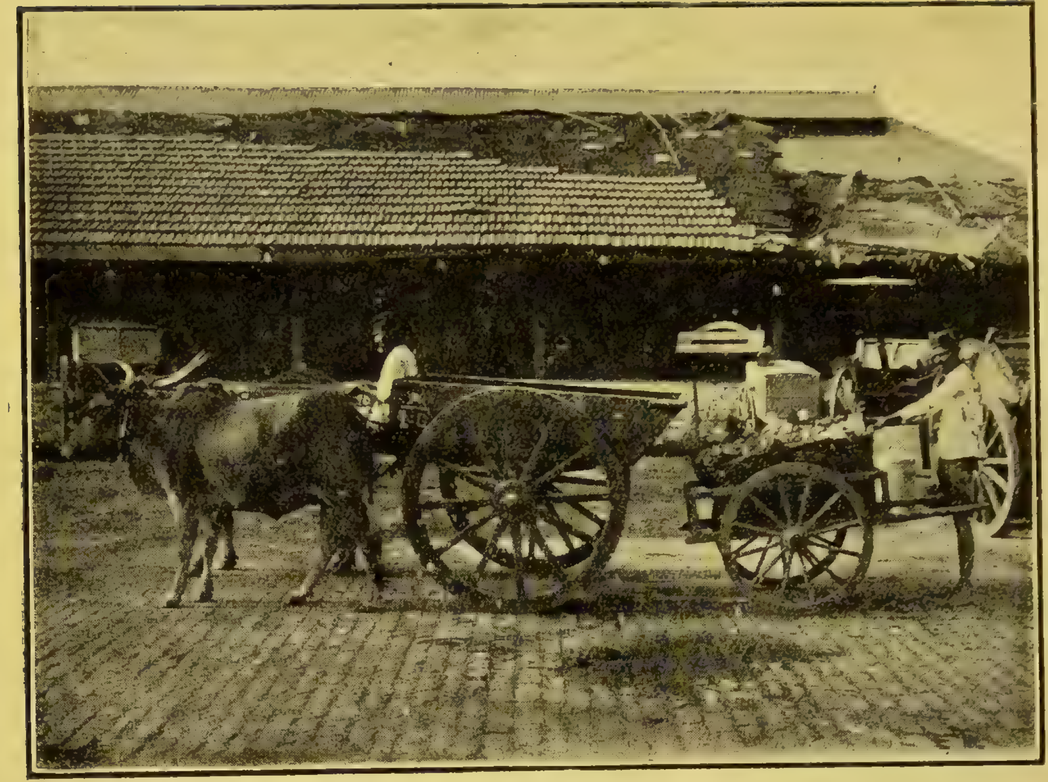
The men sweep up the refuse and the women carry it, either to a standing dustbin cart or a travelling cart. The orderly boys pick up horse and bullock droppings.

Hand barrows are used in some places where larger quantities of heavy refuse are collected in small areas, and have to be taken to distant stands.

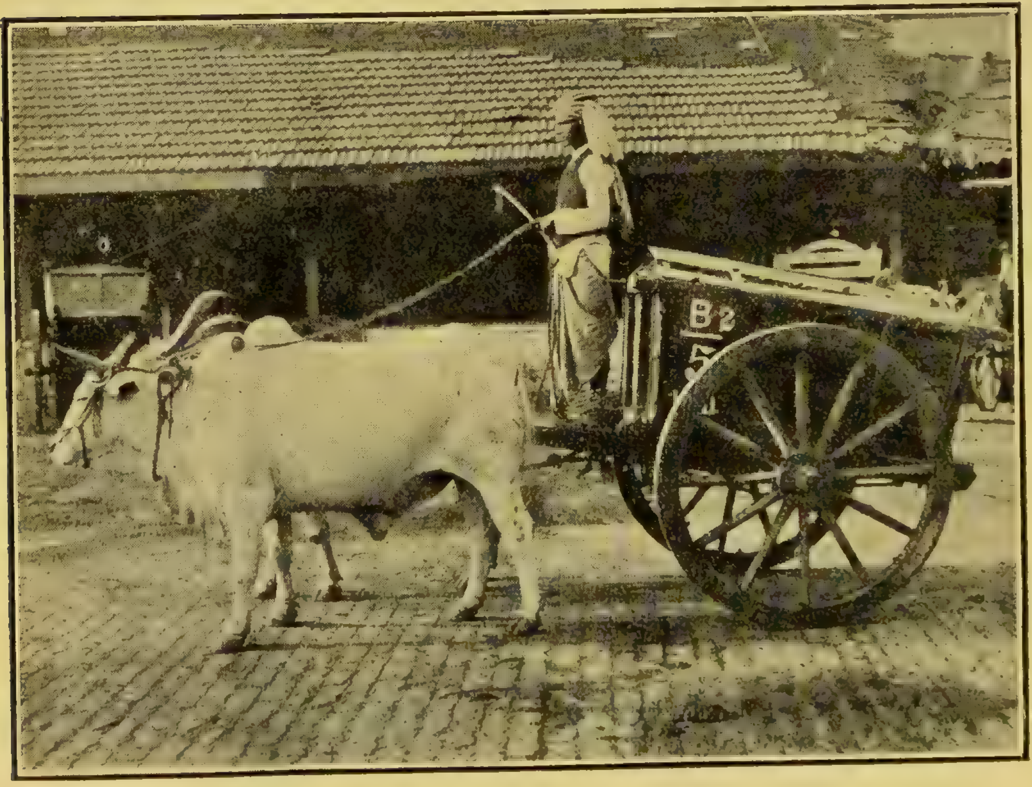
The removal of household refuse from the compounds of houses is by sanitary bins.

1,000 sanitary dust bins are in use at present and they are emptied twice daily ; in this way something like 30 tons is removed daily.

The refuse from the southern half of the Ward is carted to the Colaba Loading Siding, where it is deposited into wagons and removed by the B. B. & C. I. Railway Company.



Drain Cart and Hand Barrow.



Covered Cart for Street Sweepings.

Six wagons are utilized daily, and about 90 tons are thus railed to the flats instead of being carted through the City. The refuse from the northern half of the Ward is taken to the Palton Road Stables and from there loaded into motors which make 5 or 6 trips each to the flats daily, taking about 5 tons pér trip.

Thus no carts of A Ward, except 4 which take market offal to the main depôt, pass through the other Wards of the City.

HIGH SIDED CART WITH SANITARY DUST BIN.

41 orderly wire cages for light street refuse and paper are provided on foot-paths; they are emptied twice or thrice daily by travelling carts.

The hours of work are from 5-30 a.m. to 10 a. m. and from 1-30 p.m. to 5-30 p.m. A gang of 30 men and 27 women come on at 10 a.m. and work till 6 p.m. on prominent roads, attending to dustbin carts and the sweeping of prominent streets.

In addition to sweeping, about 50 gullies are flushed daily.

Two engines are employed with the following staff:—

2 Drivers.
2 Firemen.
4 Horsemen.
34 Begaries.
2 Sub-Inspectors.
2 Muccadums.

The staff also sweep several compounds for which charges are preferred against the owners.

Steam or Petrol Motors.

The capacity of the existing dustbin carts in Bombay is 30 cubic feet. The maximum dimensions of the carrying body for a motor vehicle are about 11′-5″ long × 6′-3″ broad × 4′-3″ high, or 303 cubic feet. The minimun is 11′-3″ × 5′-10½″ × 4′-0″ or 264 c.f. The new ones, being of the larger size, carry 12 to 14 cart loads of refuse giving a load of 6 tons.

One spare vehicle for every two in service would be required to ensure regular runnings.

The initial cost of each set of three motor vehicles would be about Rs. 36,000 and to work them in two shifts (8 hours each) would cost (with one motor in reserve)—

	Rs.
3 Drivers at Rs. 45-4; 3 fireman at Rs. 17, 2 cleaners at Rs. 12, and allowing for absentees, etc.	3,862.21
Coal (almost a ton a day)	8,707·75
Wood	182.00
Oil	1,650·50
Packing	22.03
Grease	34·25
Repairs	1,500.00
Fitter	720.00
Lighting	50.00
Supervision	1,000.00
Fillers, 40 men at Rs. 10½, less absentees ..	3,700.00
Inspection fee at Rs. 10 per motor	30.00
Interest on Rs. 36,000 at 4%	1,440.00
Sinking Fund	3,906.00
	Rs. 26,804.74

In working out the cost of the motor service per ton-mile, for comparison with the existing bullock service, interest on capital expenditure may be neglected and the cost per annum will be taken at Rs. 25,364.

Cost of removal of refuse up to the loading siding Rs.25,364 per annum to which the cost of unloading at Tardeo, *i.e.*, Rs. 1,848 per annum, has to be added ; total cost Rs. 27,212

Ton-miles per day—21 miles loaded by 36 tons (6 tons and 6 trips) × 2 motors=1,512 × 365=551,880 ton-miles.

Cost per ton-mile Rs. .049 or 9 pies.

DISPOSAL OF REFUSE.

Refuse of the City having been collected and conveyed to the place where it has to be disposed of, the method of disposal must be considered.

The tendency of sound Municipal administration is to utilise all waste to profit.

In rural and semi-rural districts, marshy and waste land can with advantage be reclaimed by depositing refuse

In many places this is done with profit ; in India, especially, this is a sound method, particularly in towns and places which would otherwise be swamps. Land thus reclaimed in the neighbourhood of Bombay brings in a large income, the right of cultivation being sold annually.

In large cities, where the expense of haulage is very great, refuse is disposed of by destructors ; other methods are also employed which dispose of the refuse in some way.

Among these methods are :—

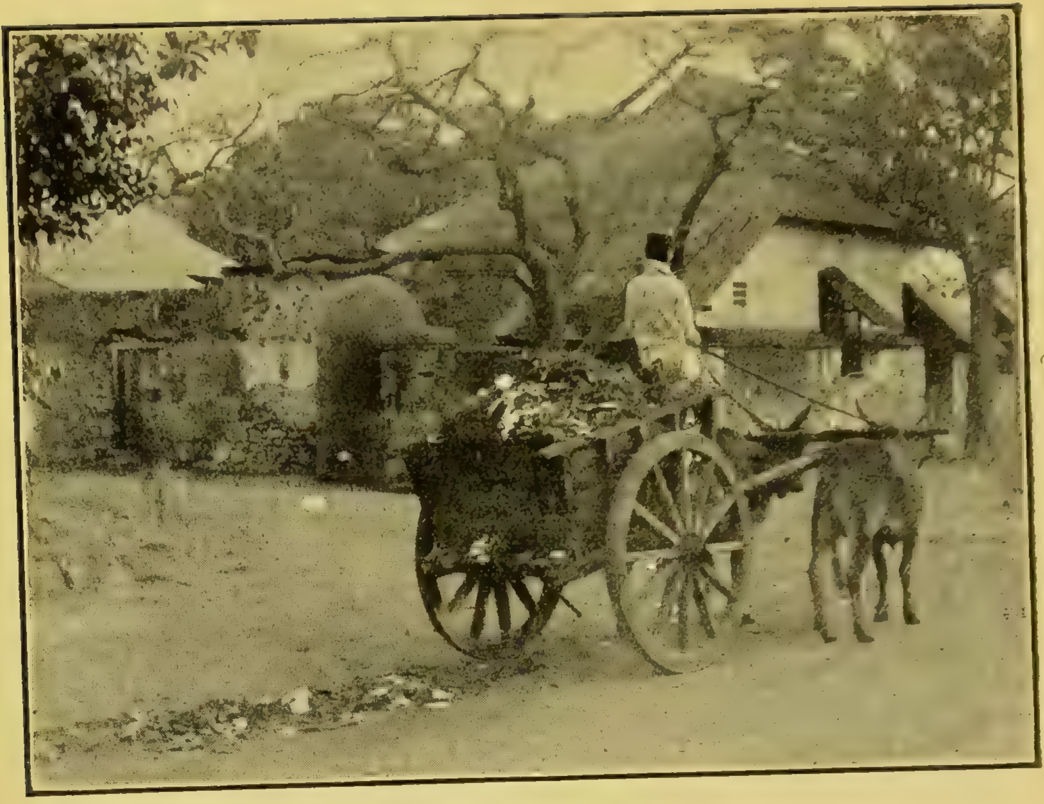
Mixing with earth and excreta and disposing of as manure.

Taking away in barges, by canal or river.

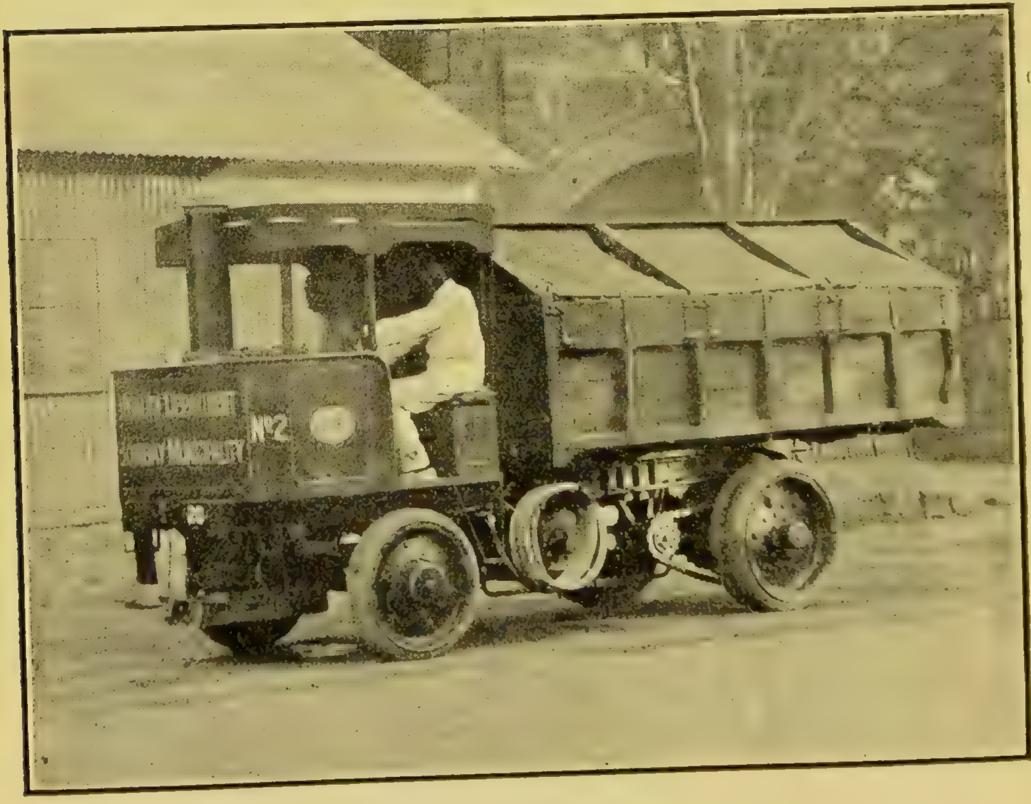
Taking into the sea in barges and sinking in deep water.

Selling to cultivators, brick-makers, manure-makers, &c.

From a sanitary point of view, the best method of disposing of refuse is that, in which the refuse is got rid of in the quickest way with the least handling without dust or smell, preventing accumulation near houses.



Old Style, Bombay.



New Style, Bombay.

In most of the cities of India the refuse is carted to dumping grounds either directly by bullock carts or by rail.

The dumping ground should be well outside the city limits, the refuse discharged on to the ground and covered with a few inches of soil, and planted with suitable crops: maize, sugar-cane and a number of vegetables do well.

Land reclaimed with street sweepings in Bombay brings in from Rs. 75 to Rs. 100 per acre from cultivation. The land is put up to auction and with facilities for transit fetches these prices.

The land is prepared in May and, on the first appearance of the rains, maize, cucumber and gourd are planted—all in the same field in rows. When these crops are well-established in July or August, brinjals and bean are planted amongst them. The maize is collected from the plants and the stalks are beaten down and form a frame for the gourd and cucumber; vegetables and spinach are then planted and this is carried on until March:

English Name.	*Marathi Name.*
Maize or Indian Corn	Kanas.
Cucumber	Kákadi.
Gourd	Shiroli.
Brinjal	Wángi.
Legume	Gowár.
Spinach	Bháji.

WEIGHTS OF STEAM MOTOR REFUSE WAGGON AND BULLOCK CARTS USED IN BOMBAY.

STEAM MOTOR REFUSE WAGGON.

Tare.		*Loaded.*	*Weight of refuse.*		
Tons.	cwt.	Tons.	Tons.		Tons.
5	14	....	5½	to	6

NEW PATTERN TWO-WHEEL CART.

			Loaded.												
Tare.			*Light refuse.*			*Heavy refuse.*			*Weight of refuse.*						
Cwt.	qr.	lbs.	Cwt.	qr.	lbs.	Cwt.	qr.	lbs.	Cwt.	qr.	lbs.		Cwt.	qr.	lbs.
9	0	8	10	1	7	16	3	21	1	0	27	to	7	3	13

NEW PATTERN FOUR-WHEEL CART.

Loaded.

Tare.			*Light refuse.*			*Heavy refuse.*			*Weight of refuse.*						
Cwt.	qr.	lbs.	Cwt.	qr.	lbs.	Cwt.	qr.	lbs.	Cwt.	qr.	lbs.		Cwt.	qr.	lbs.
13	2	21	22	1	23	30	0	4	7	2	9	to	17	1	11

HIGH-SIDED TWO-WHEEL CART.

Loaded.

Tare.			*Light refuse.*			*Weight of refuse.*		
Cwt.	qr.	lbs.	Cwt.	qr.	lbs.	Cwt.	qr.	lbs.
9	3	3	18	3	7	9	0	4

WEIGHTS OF REFUSE.

Dry	Light,	4	lbs. per cubic feet.
	Heavy,	30	,, ,, ,, ,,
Wet		42	,, ,, ,, ,,

MEASUREMENTS OF STEAM-WAGGONS AND REFUSE CARTS.

	Old.	*Capacity.*		*New.*	*Capacity.*
L	11′-3″	220 C. F.	L ..	11′-5″	303 C. F.
B	5′-10½″		B ..	6′-3″	
H	3·4		H ..	4·3″	

NEW PATTERN TWO-WHEEL CART.

	Bottom.		Top.
L ..	4·2		4·4
B ..	3·0		3·5 = 30–35 C. F.
H ..	2·4	Average.	

NEW PATTERN FOUR-WHEEL CART.

L ..	8·0
B ..	3·6½=106-20 C. F.
H ..	3·9

TWO-WHEEL HIGH-SIDED CART.

	Bottom.	Top.
L ..	4·2	4·9
B ..	3·1	4·0=57-81 C. F.
H ..	3·8	

SUMMARY OF THE PRACTICAL APPLICATION OF THE FOREGOING BY THE SANITARY OFFICIAL IN INDIA.

In tropical and sub-tropical climates, the necessity for the removal of refuse is increased by reason of the higher temperature, especially in moist atmosphere, accelerating decomposition.

Flies, mosquitoes and vermin multiply more rapidly, and bacteria, harmless and otherwise, propagate in suitable surroundings. The necessity of immediate removal of refuse and cleansing of premises is obvious. The conditions of life and the habits of the people are in themselves important factors, which have to be considered.

Ninety per cent. of the inhabitants of India have no conception of the value of sanitation, and the Sanitary Officer becomes as much a teacher as an executive officer, and this is an important part of his duty if he desires success.

It is a common thing to see a room occupied by the poorest, full of shining brass pots, but how are these pots cleaned ?

Road scrapings and dirty water, cow dung and silt form the material of cleansing. The milkman or *Gowli* cleans his milking pots in the same way : any moist earth, cow dung or sand available is used, and mixed with water from a dirty stream, foul well, or wherever it can be had.

At the bathing places where hundreds congregate, round a well or tank or stream, the clothes and mouth and teeth are all washed in the same water, while others can be seen cleansing their pots and cooking utensils and milk vessels with the dirty water and road scrapings surrounding the bathing place.

The practice of expectorating anywhere, and at any time, is so frequent as to be unnoticed by anybody, while a man will clean his nose with his hand, and wipe his hand on the nearest projection, lamp post, wall, a passing cart or his clothes.

Public latrines and urinals are provided, but are more often misused than not, while every corner or house-gully is used as a urinal even if accommodation is only a few feet away.

Every form of filth is thrown out of the window on to the street, and packets of paper or leaves containing excreta may constantly be seen descending on to the pavement or street, very often on the head of a passer-by.

In the most crowded thoroughfares of large cities, it is a common thing to see people performing their ablutions on the pavement, or sitting at their shop doors, washing themselves, and the waste water running across the footpath.

Every form of waste material is thrown on to the streets, the idea being that the Municipal sweeper will pick it up.

In many of the houses of the poor, are to be seen goats and fowls, sometimes cows and calves, living in the same room, the animals living on the refuse in the streets and shops.

In towns where Sanitary laws and bye-laws exist, some attempt can be made to improve these conditions by constant inspection, supervision, action and instruction.

The following Notices are issued in Bombay and action is taken against the offender :—

NOTICE.

WASTE PAPER FROM OFFICES AND TRADE REFUSE.

A great nuisance is caused by the Hamals of shops and offices depositing all the waste papers, wrappings, cardboards, sweeping, &c., &c., in the wire cages on the footpath. These cages are simply meant to be orderly boxes to hold small quantities of paper and dry materials picked off the passages and streets pending the arrival of the conservancy carts.

The proper place for the deposit of the waste paper and sweepings from your Office is the dust-bin cart or the travelling cart which calls 3 times a day between 6 a.m. and 9 a.m., 9-30 a.m. and 10-30 a.m., and 2 p.m. and 4 p.m. I must therefore request you to instruct your sweepers not to deposit office waste paper or dust or sweepings in the wire cages but to either send it to the nearest dust-bin stand or place it in the travelling cart which passes your door thrice daily. If you will provide a sack, the waste paper can be easily removed without nuisance to you or the public if you will make an arrangement with this Office. Trade refuse is not removed by the Municipality free of charge but must be taken at the producer's expense to Mahalaxmi Refuse Siding.

I attach a formal notice an infringement of which renders you liable to a penalty.

I have, etc.,

....

Executive Health Officer.

NOTICE.

The attention of occupiers of houses and premises is drawn to Sections 372 (*e*) and 373 of the Municipal Act which provide respectively (1) that no person shall throw or place any dust, ashes, refuse or rubbish or any excrementitious or polluted matter on any street, or in any place not provided or appointed for this purpose under Section 367 or 368; and (2) that if it shall be shown that dust, ashes, refuse or rubbish or any excrementitious or polluted matter has or have been thrown or placed on any street or place in contravention of clause (*e*) of the last preceding Section from some building or land, it shall be presumed until the contrary is proved that the said offence has been committed by the occupier of the building or land.

Dust-bin carts are placed at the most suitable places for the deposit of refuse.

Any one contravening the provisions of Section 372 (*e*) will be prosecuted.

....

Executive Health Officer.

Frequently, however, on account of the leniency of the Magistrate or want of evidence, or some technical detail, conviction fails, or the fines imposed are so trivial as to be ludicrous, and the efforts of the public health authorities are in vain. Nothing but constant action and support by the Magistrates will ever have any effect.

Any relaxation in the efforts of the officials, and the people relapse into their primitive habits.

Sanitary dust-bins and boxes should be insisted upon for every house, floor and shop, for the deposit of refuse, and a basket or bag for waste paper.

Every person found throwing refuse on to the street should be fined, and every person spitting in a public place should be prosecuted. Any one urinating in a place other than a urinal or latrine and any one misusing a latrine severely punished.

In a milch cattle stable, the washing place for the animals is also used by the milkmen for their domestic ablutions, and it is common to see a man wash himself, his clothes and his throat in the same place as he cleans his vessels in, using the waste water, sand and cow dung, &c., wiping out the vessel with a wisp of litter from the cowshed.

Every milkman or milk seller found cleaning his pots with anything but clean water should have his license taken away.

These are matters which have to be considered when applying practical sanitary methods in the East; and the best way to apply them is by steady insistence on the regulations, assisted by instructions from the sanitary staff and male and female health visitors coming in touch with the people and the support of the educated classes.

Incinerators or Destructors.

The term "destructor" is applied to a high temperature furnace specially designed for the disposal of town refuse by burning.

Many years of practical experience has led to the design off efficient types of destructors, and has shown what is the true calorific value of average town refuse, so that manufacturers are now able to give definite and reliable guarantees of performance, such as both users and makers may, with a reasonable degree of certainty, expect to realise. The mere disposal of the refuse is not, as a rule, the only consideration kept in view in a modern refuse destructor station. A complete installation for a population of, say, 50,000 persons may cost from £ 5,000 to £ 6,000 to erect, according to local circumstances, and, in addition to the destructor cells proper, usually includes machinery and plant for the removal and disposal of the residual clinker, for its crushing and manufacture into paving slabs, bricks, mortar, or other saleable products, also steam and engine power for actuating the various plant required at such a station. It will, therefore, be evident that the working expenses, maintenance, and depreciation of a fully equipped installation must necessarily be considerable, and that, with the view of reducing this annual expense to a minimum, it becomes necessary to turn to account any and every by-product or residual material which can be really diverted to profitable use.

POINTS TO BE ENQUIRED INTO WITH REFERENCE TO REFUSE DESTRUCTORS.

SUGGESTED BY FRANCIS WOOD.

1. The grate area and the amount of refuse burnt per square foot of grate area.
2. Do the fumes of the burning refuse pass over bright heat to ensure their perfect combustion ?
3. The lowest temperature in the furnace, or in the combustion chamber, should be 1300° F.
4. The temperature at the chimney flue, and at the combustion chamber.
5. The analysis of the gases at the flue should be procured. There should be less than 1 % of CO. The amount of free O and N should approximate the amounts found in the atmosphere near the flues. CO_2 should be abundant, 6 % being frequently got ; as much as 15 % has been obtained.
6. The amount of water evaporated at 212° F. per pound of refuse per hour.
7. The cost of labour per ton of refuse delivered.
8. Cost of maintenance, together with the number of men required to work.
9. Is skilled labour necessary ?
10. What method is employed to feed the destructor ?
11. The construction of the destructor. Is an inclined road-way necessary ? Height of chimney.

12. Disposal of clinker, and revenue derived from its sale.
13. The number of cells required for every 10,000 inhabitants.

In large towns the destructor will be found to be the best method of disposal.

Destructors are so constructed that the nuisance is reduced to a minimum, and in large towns in England are in some instances placed close to dwelling houses, schools, &c.

The best known destructors are :—

Horsefall.
Beaman and Deas.
Meldrum.
Heenan and Froude.
Sterling
Baker.

The following is a description of the Horsefall Destructor :—

The buildings are laid out in four bays, the destructor furnaces occupying the bay nearest the entrance. This bay is 110 feet long, by 40 feet wide, by 41 feet high. The two centre bays accommodate two sets of boilers for destructor and coal firing respectively, while the east bay (the largest of the four) is the electric power station.

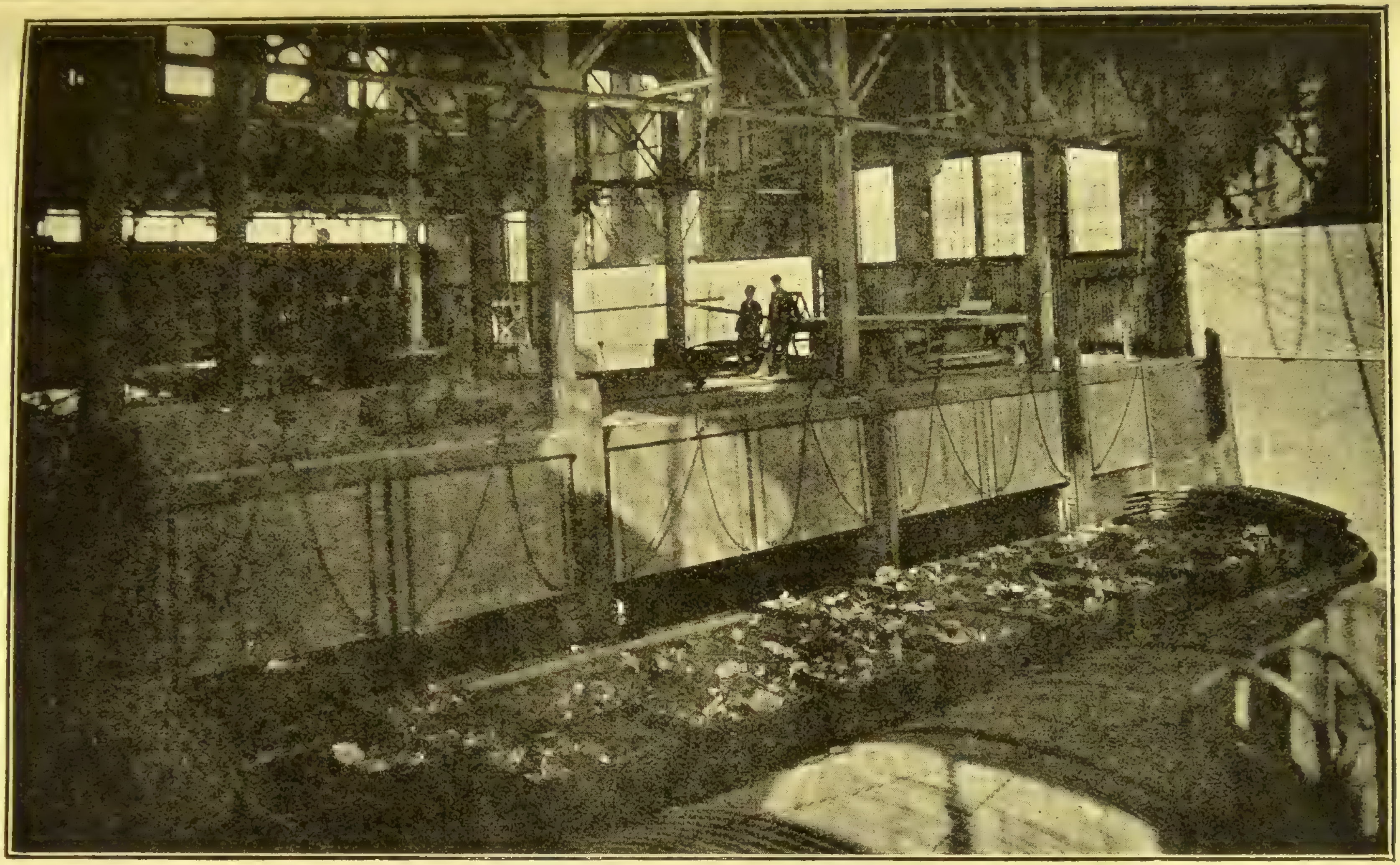
A pump-room, which serves both sets of boilers, adjoins the power station ; and the economisers, of which there are two, are housed outside the main building.

The chimney, 150 feet in height by 10 feet internal diameter, is situated at the end of the boiler-house.

A concrete retaining wall and water reservoir is built at the south end of the site, and water is conveyed by an 18 in. pipe from the reservoir into the power station for condensing purposes.

Details of the Destructor.

The Horsefall Destructor consists of six large cells and combustion chambers, with three water tube boilers, arranged so that each pair of cells with its boiler can be worked independently. This arrangement of independent "units" permits of any section of the plant being shut down for repairs or cleaning, without interfering with the working of any other unit.



Refuse for Incineration.

By firing the two cells of each unit alternately, a steady steam pressure is maintained in the boiler, while the combustion chamber is also kept at a sufficiently high temperature to cremate thoroughly the noxious gases which escape from the newly-charged refuse.

The furnace grates, which slope from back to front, have each an area of 25 square feet and are constructed to burn efficiently a full cart-load of refuse at one charge. The grate bars are perforated with a large number of small holes and a high pressure blast is forced through these, by means of electrically driven fans.

It is generally recognised that, to ensure complete combustion in destructor furnaces, an air-blast system is the best, but hitherto the blast has been deliverd at comparatively low pressure.

The grates and fans are constructed for a specially high pressure, and are fully expected to show a distinct gain in efficiency over the older system.

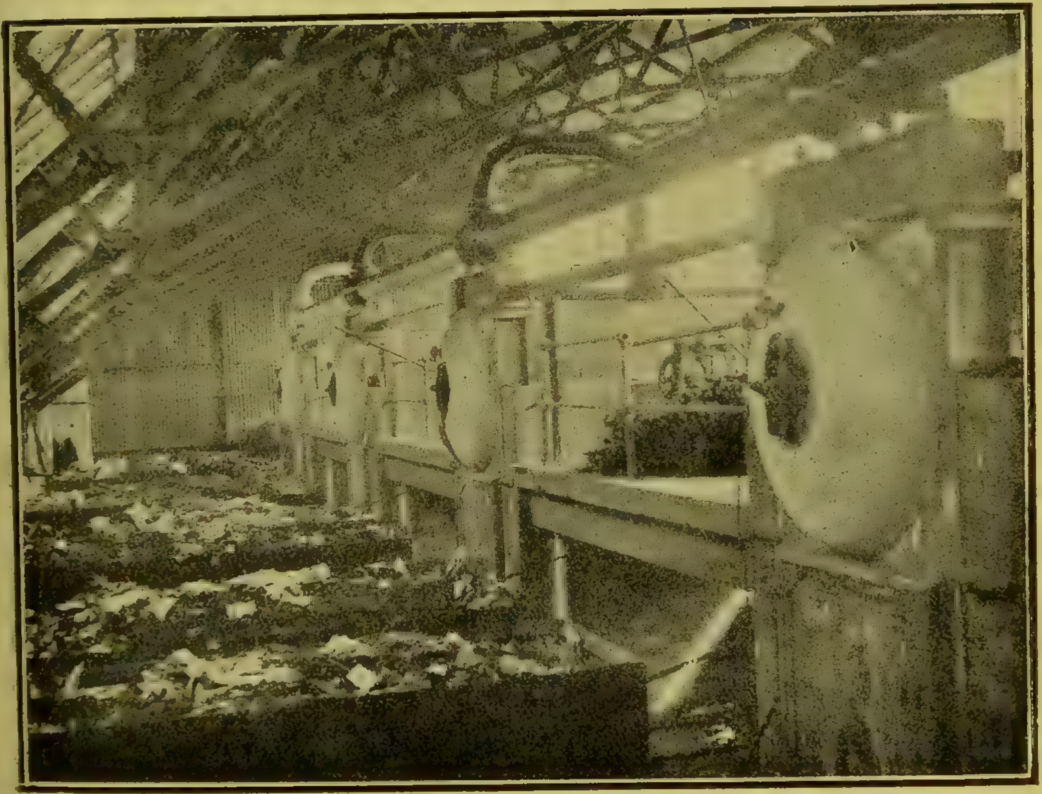
The fans, of which there is one to each furnace, are coupled direct to " phœnix " variable-speed motors of the totally enclosed type. The starting and regulating switches are fixed conveniently to the furnace doors, and a throw-off switch is actuated in such a way that the opening of the door automatically stops the fan. Incidentally an attempt has been made to improve the unfavourable atmospheric conditions existing in most destructor installations, and ventilation is provided for by carrying the fan inlets to the underside of the storage platform and turning them inwards, so that all dust and fumes emitted during the process of " clinkering " are drawn in and delivered back to the fires.

Auxiliary steam jet fittings for steam blast have also been provided, but these are only intended to be used in the event of a breakdown to the fans.

The system of charging.

The method of storing and charging the refuse into the cells has been specially designed to reduce manual labour to the lowest possible minimum, and forms a striking comparison to some types of destructor still in use, in which the refuse is stored in loose heaps and fed into the furnaces by hand labour.

The refuse is delivered from the carts to the furnaces without handling of any kind, and, while effecting a saving in the cost of labour, ensures a degree of cleanliness which is really remarkable, having regard to the nature of the materials dealt with.



TUBS CHARGED READY FOR INCINERATION.

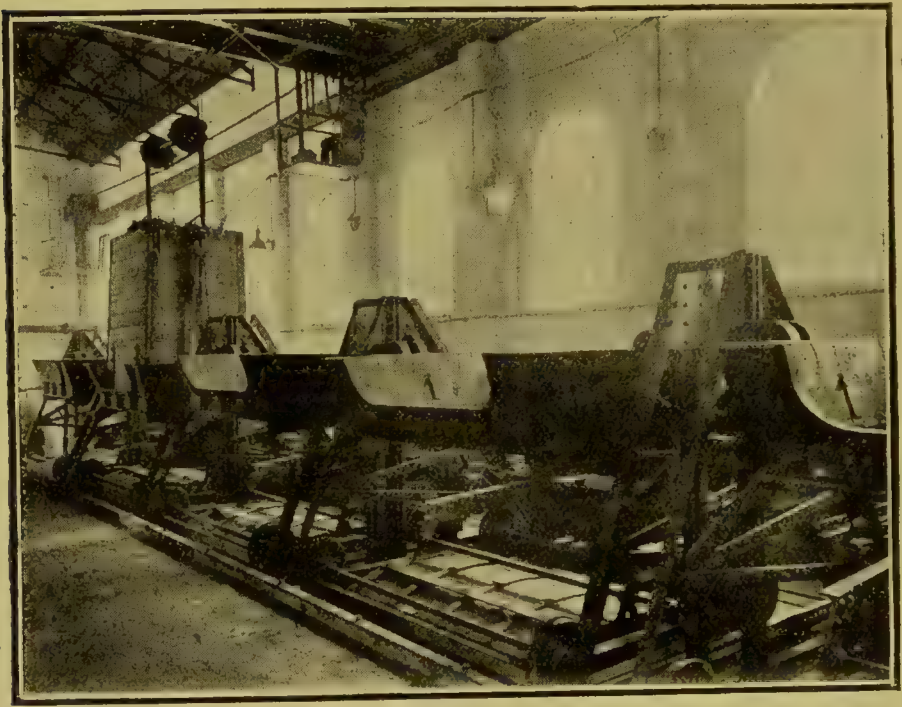
The tipping pit is situated at the north end of the destructor house, and the refuse, which is delivered by carts, is discharged through a specially shaped hopper into a storage tub placed ready in the pit.

The pit has accommodation for four tubs, with two hoppers, the latter being arranged to move on rails across the pit.

When the tub has been loaded, the hopper is moved clear from above it, and an electrically operated overhead crane lifts the tub and deposits it on the storage platform, where it is kept till required. The storage platform extends to the full length of the furnace blocks, and has accommodation for eighty tubs.

The storage of refuse thus takes place in closed boxes away from the heat of the destructor.

When ready to charge, a tub-full of refuse is lifted from the storage platform by crane, and placed on a moveable cradle on the top of a cell. The weight of the tub causes the cradle to descend, and by a system of levers and balance-weights, the water-sealed door is lifted from its seat, and drawn on rails to one side, permitting the lower edge of the moveable cradle to descend into the mouth of the charging doorway. The storage tub is provided with hinged lids at the bottom, which are held shut when the tub is suspended by the crane, but when released these lids open outwards, and the whole of the refuse thus falls directly into the furnace and spreads itself over the grate.



"TUB-FEED DESTRUCTOR OF THE MERSEY DOCK HARBOUR BOARD, AT LIVERPOOL.
CHARGING GEAR.

The empty tub is then lifted by the crane, and the water-sealed door, actuated by the balance-weight, is mechanically drawn back to its seat. The whole operation of charging the cell and withdrawing the tub occupies less than a minute, and as the furnace door is open for only a few seconds, the inrush of cold air, with consequent reduction of furnace temperature, is reduced to the smallest possible amount.

The crane which has a lifting capacity of 3 tons at 30 feet per minute, was built by Messrs. Broadbent and Sons, Huddersfield.

The time required to cremate a charge thoroughly varies according to the class of refuse, from one to one and a half hours, and the fire is then cleansed through a large clinkering door at the front of the cell. This door is of specially strong construction, and is provided with two small doors attached to it, so that the fires can be adjusted and managed without opening the main door.

The clinker is withdrawn from the furnace into buckets suspended from an over-head clinker railway, and may either be delivered directly to the clinker crushing and screening mill or deposited in heaps until required.

Boilers.

A main flue of large area is provided for each pair of cells from which the hot gases are carried through the combustion chamber of water-tube boilers, and a dust catcher of Messrs. Horsefall's patent type is built in between the combustion chamber and the boilers. All the flues are lined throughout with fire-brick, and in the furnaces specially made fire-clay blocks, set in fire-clay cement, have been employed.

The boilers are of Messrs. Babcock and Wilcox's marine water tube type, constructed for a working pressure of 200 lbs. per square inch, and fitted with superheaters to raise the temperature of the steam to 500 deg. Fahr.

To meet any special demand for steam, auxiliary grates have been fitted for coal firing, and a bye-pass is provided direct from the destructor combustion chamber to the main overhead flue, so that in the event of a breakdown to a boiler or an excess of steam being generated, the whole or a portion of the hot gases may be taken by this route instead of through the boilers.

After leaving the boilers, the gases pass by way of the overhead main flue to an economiser, thence to the chimney.

The economiser is of Messrs. Green's type, built into two sections of 120 tubes each.

The steam from each boiler is led from the superheater to a 10 inch main, and carried direct to the main rang which supplies the electric generators. The feed piping is connected by a branch pipe to the system supplying the coal-fired boilers, the arrangement being designed so that the destructor boilers can be fed either through their own economiser or from the hot-feed main of the coal-fired boilers.

The pump-house contains two triple-throw electrically driven Worthington pumps, and one of Messrs. Weir's double acting steam pumps. A storage tank of 12,000 gallons capacity is placed over the pump room, and a combined water-softening and de-oiling plant is provided to treat the feed-water.

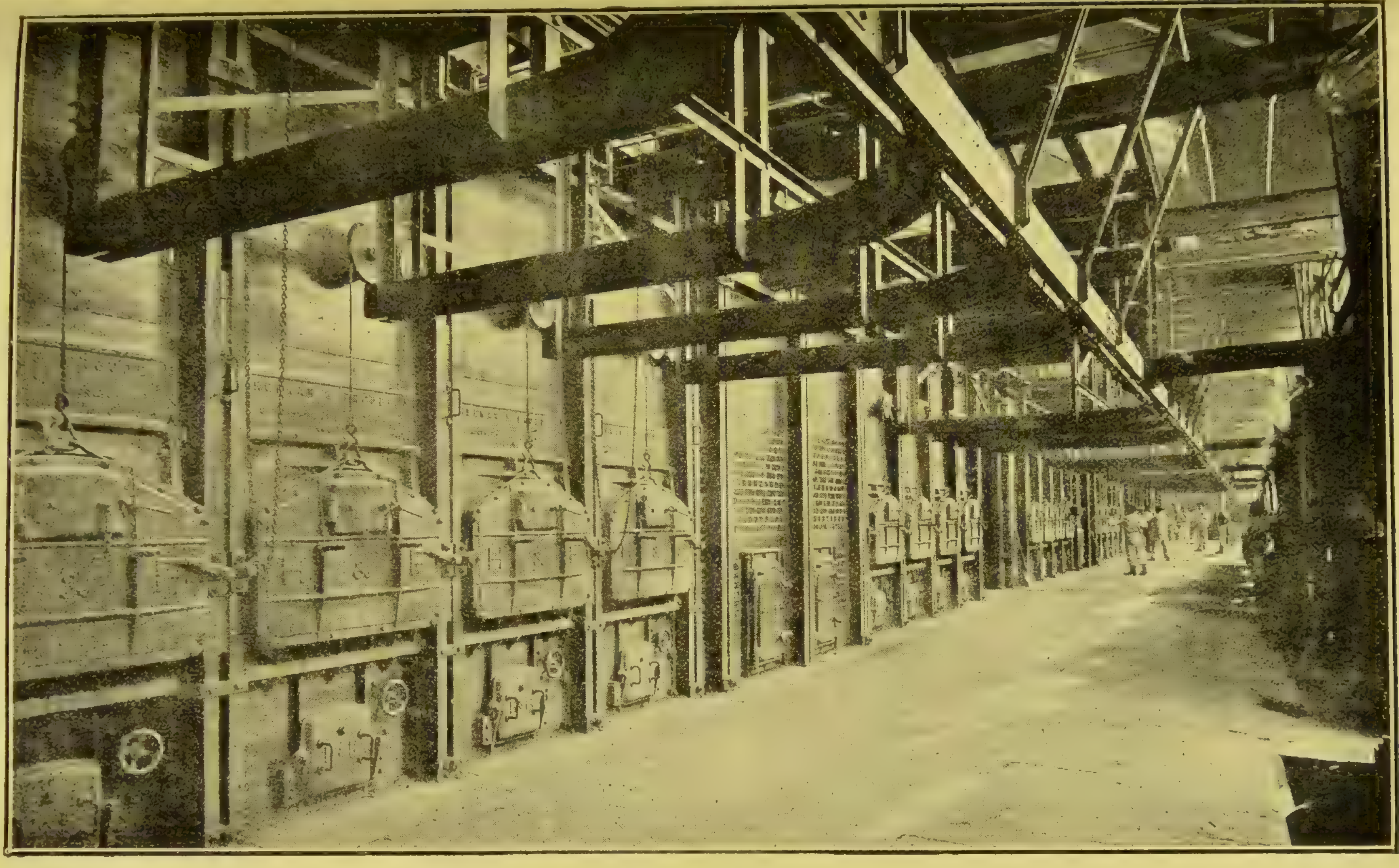
The coal-fired boilers are of Messrs. Babcock and Wilcox's double-drum type, each boiler being capable of evaporating 18,000 lbs. of water per hour. Superheaters are provided, and the firm's latest type of chain-grate stoker is fitted.

Generating Plant.

Passing into the engine room, a lofty, well-lighted building, there are two Bellis-Westinghouse direct coupled generating sets, each capable of a normal output of 750 kilowatts when supplied with steam at 200 lb. pressure.

The engines are of the triple-expansion, quick revolution, enclosed type of 1,140 horse power each, and are fitted with expansion valves to take over-loads up to 50 per cent.

The exhaust steam is taken through an oil separately into a surface condenser, which serves both sets of engines.



Clinkering floor of Incinerator.

A special feature of the works is the use of the electrically driven auxiliaries, and the whole of the auxiliary plant, including pumps, stokers and fans, is driven by electric motors.

The following observations as to the general methods of working the Fryer Destructor apply also, with slight modifications to meet special circumstances, to all hand-fed destructors.

"The cart, on entering the yard in which the destructor is built, is drawn by a horse up an inclined roadway with varying gradients of from 1 in 12 to 1 in 25, and on arriving at the top a platform is provided with tipping curbs, against which the carts are backed, and their contents are tipped on to the top of the cells. Here the material remains for a short time, until one of the cells is ready for a charge, the charging holes being in direct communication with the fire, but so arranged that very little smoke at any time issues from them. When a cell requires to be charged, the material is shovelled or drawn with a two-pronged rake into and on to the top of the charging hole. A second man stand in line with the opening, and as the material is delivered on to it he pushes it down the incline on to the drying hearth and continues doing so until the hearth is completely covered. The quantity usually put on at one charge varies from one-third to one-half a cart load, or from 20 cubic feet to 30 cubic feet. From the drying hearth the material is drawn down on the bars as required by the fireman, who stands at a lower level and in front of the furnace. He first clears his fire by pulling the clinker out, spreads the burning material evenly over the fire bars, and then draws down a fresh supply of the partially dried material from the drying hearth. He usually finishes up by running his bar through the fire, so as to leave as free a passage for the air as possible.

"Too much refuse should not be drawn down at once, or the fire will become dead and blackened. Thin layers may be racked down at intervals of about 20 minutes, but the fires should be undisturbed for at least half an hour before a clinkering. The fire on the bars (which should always be kept covered) should not be more than about 9 inches thick, which is sufficient to secure a clear fire.

"The clinker falls into a barrow provided for the purpose or upon the ground in front of the furnace, where it is cooled, by having water from a hose sprinkled upon it. The fine ash drops through the bars into the dust hearth, and it is found that the material in passing through the furnace is reduced to about 25 per cent. of its weight. This residue consists partly of fine ash and partly of clinker, in varying proportions according to the character of the material which has been consumed. Whilst the combustion is proceeding, the hot gases from the furnace or cells escape over the bridge into a central flue 6 feet high by 10 feet 4 inches wide. This is arranged to prevent too great a velocity from carrying pieces of paper and other unconsumed material to the chimney, and also to allow of the deposit of dust within the flue."

The Meldrum Furnace.

The Meldrum patent "Simplex" Destructor is a modern apparatus manufactured by Messrs. Meldrum Bros., of Manchester. In this furnace, it is claimed, ordinary town's refuse will give a sufficiently high temperature to utterly decompose all noxious material, nothing but harmless and inoffensive gases passing up the chimney, the solid residue consisting entirely of hard clinker with a little ash. When it is desired to utilize all the available heat for steam-raising a special internally fired steam generator is employed.

Ordinarily, the furnaces are fed by hand, but hopper feeding may be arranged if required. A forced draught is used in connection with the furnace, but no cremator is considered necessary, owing to the high temperature of the cells.

It will be observed that four grates are placed side by side and separated only by dead plates, the ashpit, however, being divided in four parts, each separately fed with a supply of air under pressure, preferably by steam air blast. The destructor, therefore, is practically a single cell, fed and cleaned, in four places at regular intervals, so that an approximately constant temperature may be anticipated.

The escaping gases either pass away from the back of each fire grate into a common flue leading to boilers or the chimney, or are conveyed sideways over the various grates, and thence over a common fire-bridge towards the boilers or chimney. After passing the fire-bridge, it will be seen, there are five rows of baffle pillars arranged to divide and break up the current of hot gases; the pillars remain constantly at a bright red or white heat, and take the place, it is claimed, of the cremator furnace commonly used in the older destructor installations. A bye-pass is, of course, provided in order that the furnaces may be used without the boilers. The patentees recommend that four grates be laid down, but fewer or more may be provided to suit circumstances. One or more of the grates may be disused without interfering with the working of the remaining portion of the destructor.

In regard to the question of the number of "Meldrum" cells required proportionately to any given population, if we take the annual production of house refuse per 1,000 inhabitants at 200 tons, then a single "cell," that is, a grate 5 feet by 18 feet, having four ashpits, and burning at an assumed average rate of 40 lb. per square foot per hour, would consume about 38 tons per day of 24 hours, or per year of 300 days—say, 10,000 tons. Consequently, if this rate of consumption be uniform and constant throughout the year, such a cell or destructor should suffice for 50,000 people. The heat derived in indicated horse-power per cell would theoretically—assuming a maximum of 2 lb. of water evaporated per lb. of refuse consumed—be equal to $\dfrac{90 \text{ sq. ft.} \times 40 \text{ lb.} \times 2}{20} = 360$ horse-power continuously per cell at 20 lb. steam per 1 horse-power per hour.

A height of chimney shaft of 40 ft. is said to be ample for the requirements of the "Meldrum" furnace; and the temperature in the cell, if fitted with regenerator, may be taken as averaging about 2,000 deg. Fah.

Beaman and Deas Destructors.

One of the most modern destructors is that of Beaman and Deas.

The material to be burnt is carted up a short incline to the top of a platform, which measures only 8 ft. 9 in. from the ground level, and is tipped direct into a hopper mouth about 1 ft. 6 in. square; after passing which it falls down a fire brick hearth supported on T irons, and having an inclination with a horizontal line of about 52 deg. At the bottom of this incline the refuse is received upon a fire-grate area 5 ft. square, which is fixed level at a height of about 2 ft. 9 in. above the floor of the ashpit. The fire-bars are of the ordinary stationary type, these having been found by experience to give the most satisfactory results. They have spaces between them of only 3—32 inch and the weight of fine ash passing through from a week's work of five days—and burning about 100 tons—only amounts to 3½ cwt.

Tipping to Incinerator.

Vertically under the bridge between the furnace and the combustion chamber is an air culvert, on the top of which are the air blast pipes, about 12 in. in diameter, and which discharge into a hermetically closed ashpit immediately under the fire-bars. The air is supplied from fans at a pressure of about 2 in. of water, and is controlled by means of baffle valves worked by handles on either side of the furnace handy to the attendant. The forced draught keeps the bars cool, and the wear and tear is found by experience to be very slight.

The process of burning the refuse is briefly as follows :—

The material to be consumed is carted to the tipping platform, and, without undergoing any process of screening or selection, is discharged through the hopper, as above referred to, on to the inclined hearth. A charge is meanwhile in course of destruction on the horizontal fire-grate, and when this is consumed the furnace is clinkered, and the charge lying on the inclined hearth, which has meanwhile to a considerable extent been dried by the heat deflected from the fire-brick hearth and the general heat of the furnace, is in turn drawn on to the horizontal fire-grate, and another charge takes its place on the inclined hearth. The clinkering and re-charging of the furnace is done alternately, the better to preserve the heat in the combustion chamber, which is stated to be maintained at a temperature of 2,000 deg. Fah. Inasmuch as all the products of combustion have to pass through this chamber, it is impossible for any undecomposed vapours to escape into the main flue beyond, and one of the most important of all questions appertaining to the disposal of refuse, *viz.*, the absolute avoidance of nuisance, is thus provided for.

Description of the small incinerators in use in Madras.

Dr. W. R. MacDonald, Health Officer of Madras, thus describes the method of small incinerators in Madras :—

"These were designed and modified to suit local conditions by Mr. C. L. T. Griffith, A.M.I.C.E. (now Professor of Engineering College), while Engineer to the Corporation of Madras. It may be mentioned that his experiments were conducted under monsoon conditions in the latter part of 1910. The structure is a brick masonry one, with three rows of iron bars superimposed and each row placed at right angles to the other ; in the bottom of the furnace, ample draught apertures are allowed for, below and above is an upright masonry chimney on which is usually placed a 12′—16′ iron chimney ; an iron lid with a baffle plate is placed over the furnace, which is opened and closed by means of a wire pulley attached high up on one side of the masonry chimney. The cost of erection is a recommendation also, as the masonry work is of only Rs. 100. Rs. 25 for the iron chimney.

Separation of combustible from incombustible rubbish.

"(1) By drivers and sweepers in the divisions. In the forenoon trips a rough separation is made so that nearly all combustible material reaches the incinerator in the forenoon. What is left behind for the afternoon trips is nearly ashes, earth sweepings which contain a small quantity of organic matter. This is not usually taken to the incinerator but to the "Screeners" near by, where combustible material is separated out and carried a short distance to the incinerator.

"(2) Separation—by hand, rakes and forks is the first operation on the arrival of the carts at the incinerators in the forenoon ; women and boys do the light work of picking out brick bats, broken earthen ware utensils, tins and other incombustibles.

"(3) Screening : after the bulky burning material is separated out from these incombustible materials, a residue of earth, mixed with vegetable matter, smaller pieces of bricks, bottle, etc., is left. This is then conveyed to the 'Screeners' for finer separation with the result that we have, when screening operations are complete, a finely powdered earth with a small quantity of organic matter. Night-soil has always been carefully excluded.

"The "Screeners" are double, a large mesh in front, a smaller mesh behind, so that we get double "screening" with the same operation. The wire work of the "Screener" is of expanded metal, the large mesh being $1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ whilst the smaller is $\frac{1}{4}'' \times \frac{1}{4}'' \times \frac{1}{8}''$. The frame work is of wood on which the expanded metal is fixed by bolts. The "Screener" is placed in an upright sloping position and is supported by two supporting wooden legs hinged to the upper part of the wood work frame.

"One is constrained to believe that these small incinerators for the disposal of rubbish in Madras City have proved a sanitary and financial success, and that there is an important place for them in connection with conservancy in mofussil towns and villages in India, and Burma, where the rainfall is not excessive.

"I. *Incineration of night-soil mixed with rubbish.*—Experiments were conducted in the disposal of night-soil along with rubbish at Chetput by means of one of these small incinerators, for about one month.

"Night-soil was procured from the two sanded latrines in the paracheries near by. It was free of liquid, but slightly mixed with sand. About 15 cart loads of suburban rubbish were brought in daily. After separation and screening, night-soil was freely mixed with the rubbish and then transferred to the incinerator furnace. So far as the disposal of the night-soil was concerned the results were eminently satisfactory, as the night-soil of 400 persons (half the population of the paracheri) could be disposed of daily without difficulty. The gases given off from the incinerating night-soil, however, proved such a vile nuisance, that I was compelled to discontinue these experiments. I am of opinion, however, that by using a *dome* incinerator this nuisance can be effectively controlled.

"II. *Incineration during the monsoon.*—It will be seen on reference to the meteorological table that most of the rain for the year in Madras City falls during the months of September, October, November and December. When rain falls continuously for a day or longer, conservancy operations are entirely suspended so far as the removal of rubbish is concerned; but when rain falls during some part of the day, or night, incineration operations are retarded on account of the sodden condition of the rubbish brought in. To combat this condition various measures have to be adopted. The rubbish is separated in the usual way, and spread out to dry in the open when sunshine is available, or under a *kutcha* shed. One's experience in Madras has been that rubbish spread out for a short time in the sunshine and then sprinkled with crude kerosine oil can be disposed of by these small incinerators. Screening operations, however, have to be suspended temporarily until most of the moisture has been removed."

NOTE ON COLOMBO REFUSE DESTRUCTOR,

BY C. L. COX, ESQ.,

City Sanitation Engineer, Colombo.

"House rubbish in Colombo is collected in portable sanitary rubbish bins, the use of which is enforced throughout the City, and, together with street refuse, is removed in specially designed self-clearing single bullock carts.

2. Owing to difficulty in obtaining suitable sites, trouble in securing an efficient transport service and the sanitary objections against refuse dumping in the vicinity of the City, the Municipal Council have established a Refuse Destructor.

3. The following description of the plant and its method of operation is derived from particulars kindly supplied by the Works Engineer.

The plant is of the Horsefall Back Feed continuous grate type with six cells design to dispose of 10 tons each per 24 hours. The Hot Air blast to the furnaces is supplied by two Roots blowers drawing air through Regenerative Air Heater from the intake over the rubbish delivery hoppers. The plant includes a Babcock and Wilcox boiler, an auxiliary oil engine for the blowers, two beast cremating chambers and a dust catcher of the Accrington Patent Type.

A feature of the plant is the additional oil fuel heating apparatus for use with wet rubbish. The oil is atomized by super-heated steam and, mixed with air, is ejected into the furnaces through spraying nozzles.

The refuse delivery hopper has a storage capacity of 30 tons. The back is sloped to deliver the refuse to the feeding floors, and the openings through which the refuse is tipped are closed with balanced doors.

The plant has been in satisfactory operation for nearly a year, and the following notes may be of interest.

The rubbish contains a large proportion of sand and mineral matter. In wet weather it is 25 per cent. heavier than in dry. The capacity of the plant varies from 45 tons per diem in wet weather to 75 tons per diem in dry.

The cost of destruction, including all charges except amortization and the cost of liquid fuel for the auxiliary burners, varies between Rs. 1-30 cents and Rs. 1-50 cents per ton. A saving of 16 per cent. in rubbish transport charges has been effected by the use of the Destructor. The furnace residue which consists of broken bricks, tiles, sand, fine ash and friable clinker, amounts to about 40 per cent. by weight of the rubbish burnt. Except as filling the furnace, residue would appear to be useless, but the fine ashes are being tried on cocoanut estates and the dust from the flues and combustion chamber is stated to possess some value as a fertilizer for use on local paddy fields.

In the initial stages some trouble was caused by the accumulation of fine dust in the flues and regenerator, but this has been obviated by providing additional access and clearing openings.

The oil jets are not entirely satisfactory and the benefit derived from their use does not correspond with the heavy expenditure of fuel. The defect is attributed to the fact that the flames do not properly impinge upon the rubbish."

POINTS TO BE REMEMBERED IN CONNECTION WITH THE COLLECTION, REMOVAL AND DISPOSAL OF REFUSE (TOWN SWEEPINGS).

1. The amount of refuse per head is greater in bulk in Indian cities than in European cities.

2. The refuse is lighter in the dry season but decomposes more rapidly.

3. Refuse should be removed twice a day in India.

4. It should be disposed of as quickly as possible.

5. The amount per annum per head of the population in large cities in India is about 7 cwt.

6. The custom is for the people to throw all refuse on to the streets or passages; this should be prevented by notices and prosecutions.

7. Sanitary Dust Bins should be provided for compounds, and boxes or baskets for each floor of the house occupied by the poorer classes.

8. The refuse when collected should be taken to the place of disposal at once.

9. Each district should be divided up into areas, with Inspector, Muccadum and gang of coolies; all carts should have covers.

10. The work should be regularly checked,—trips marked at the depôt.

11. The refuse, if disposed of by reclaiming waste land, should be covered over at once with 6 inches of dry earth.

12. The reclamation ground should be well away from inhabited houses.

13. Sprinkling the refuse with pesterine will prevent the breeding of flies.

14. Land thus reclaimed should be cultivated at a profit.

15. Destruction of refuse by incinerator is the best and cheapest method of disposal.

16. To calculate the number of carts, bullocks and labour staff necessary the following data will be required :—

The population, amount of refuse to be destroyed, distance to place of disposal.

17. A cart drawn by a pair of bullocks will carry about 10 cwts. of refuse, can make 4 trips of 3 miles each in one working day.

18. One destructor cell will destroy 8—10 tons of refuse in 24 hours.

19. A population of 50,000 persons will produce domestic refuse at the rate of 40 tons a day.

20. A four cell destructor capable of destroying this amount of refuse will cost £5,000 to £6,000.

CHAPTER III.

COLLECTION, REMOVAL AND DISPOSAL OF SEWAGE.

The subject of the collection, removal and disposal of sewage in India is one of the most important the sanitary official has to deal with, as well as the most difficult. No matter whether the place involved is a village or a growing town or a large city, the all-pervading presence of the subject crops up at every turn.

The effect on public health of the present system is enormous, beginning with the persistent smell of fæcal matter, human and animal, in and around the houses, up to the pollution of the food or water supply of a large town, or the tranference of disease by "carriers."

To place the collection and disposal of human and animal excrement under proper control is one of the first principles of practical sanitation in India. It means a reduction in the sickness-rate, reduction in the mortality and an improvement in the condition of the people, morally, physically and hygienically.

Badly constructed trenches and want of supervision in mofussil towns mean the propagation of disease by the dissemination of germs and parasites by flies and dust reaching the person, his food, milk or water ; dogs contract and convey intestinal worms to cattle, sheep, goats, pigs and fowls, and thus to the human being, and while the sun has a drying and disinfecting power, the high winds disseminate the germ-laden dust. The majority of towns in India suffer from a form of Dysenteric Diarrhœa due to this pollution of food or water.

Coming to towns which are drained or partially drained, but where only few of the houses are connected, as is the case in the majority of towns in India, the sickness caused by the existing system is impossible to estimate.

The open drains receive the contents of the overflowing receptacles, the semi-fluid matter percolates through the soil or lies in the open drain and forms a breeding and feeding ground for flies, rats, mosquitoes and vermin. Even in houses, where the water-closet exists, it is the custom for the same sweeper to attend to many houses either to flush the water-closet or wash the seat and bath. This is done with the same brush or cloth in several houses and it is easy to imagine the possibility of disease being spread in this way.

Any attempt at improving the sanitation of a growing town or city will never succeed unless the collection, removal and disposal of night-soil is dealt with in the strictest and most practical manner: the collection of the excreta at regular intervals in a systematic way and the disposal either by proper trenching, incinerator, or a suitable system of drainage.

In another chapter, the measures to be adopted in Camps and Fairs are described.

AMOUNT OF EXCRETA AND COLLECTION.

Mr Fawcus' experiments on Bengalee prisoners give an average bowel excretion of 12 ounces or .75 lbs. due to the large bulk of vegetable diet eaten by Hindus. This is confirmed by the observations of Dr. Hewlett in Bombay. The volume is due to the proportion of water it contains. In addition to this there is 40 ounces of urine, and the ablution water in a Hindu population, which must be added, is estimated at 40 ounces.

In Bombay in those parts where the houses are not on the water-closet system, 2 lbs. per head per day each adult and 1 lb. for children is the amount of excreta estimated t be actually removed, inclusive of urine and part of the ablution water in the native population; 30 per cent. of th urine and ablution water and fæces passes off into the drain and cannot be collected and soaks away owing to defect in the drain and pipes.

Fresh fæcal matter from healthy persons, living on a mixed diet, has an acid re-action when mixed with urine and this it retains for a considerable time; it then becomes alkaline from ammonia. If free from urine, it usually decomposes slowly and in hot weather often dries on the surface, and subsequently changes but little (in England) for some time. In India, it is reduced to powder by the alternate action of sun and dew, and falls into the ground or is dispersed by the wind.

An adult male, living on a mixed diet of animal and vegetable food, passes 4 oz., by weight, of solid and 50 oz. of fluid excreta daily.

A daily average for a mixed population of men and women and children, on a diet of animal and vegetable food, may be taken as 2½ oz. solid and 40 oz. urine.

Taking an average of the analyses of the various authorities we find that the solid and fluid excrements of an average individual, of all nations, sexes and ages, contain the following percentages of ingredients :—

Analysis of Excrements (*Krepp*).

Ingredients.	Fæces.	Urine.
Water	75·0	93·99
Organic Substances	12.2	4.15
Nitrogen	1.4	1.42
Phosphoric Acid	1.06	0.24
Potash	0.29	0.20
Insoluble Silica	1.48	..
Oxide of Iron	0.54	..
Lime	1.72	..
Magnesia	1.55	..
Sulphuric Acid..	4.27	..
Soda	0.31	..
Chloride of Sodium	0.18	..
TOTAL ..	100·00	100·00

Nitrogen or ammonia in fæces, 1.70; in urine, 1.73; phosphoric acid or phosphate of lime in fæces, 2.30; in urine, 0.52.

In the case of an average individual the annual produce of the four principal ingredients in the above Table is as follows:—

	Fæces.	Urine.	Total.	Value.
	Pounds.	Pounds.	Pounds.	Shillings.
Ammonia (Nitrogen) ..	1·49	9·38	10·87	7·3
Phosphate of Lime (Phosphoric Acid).. ..	2·00	2·80	4·80	1·7
Potash	0·25	1·08	1·33	0·7
Organic Substances ..	10·51	22·49	33·10	0·7
Total ..	14·25	35·75	50·00	10·0

The fertilising value of excreta per head per annum of the population living on a mixed diet is stated to be equal to raising as much grain as 75 lbs. of guano, and equal to increasing the yield of grain by 3·21 bushels per acre in addition to what the land would yield without manure.

Bombay.

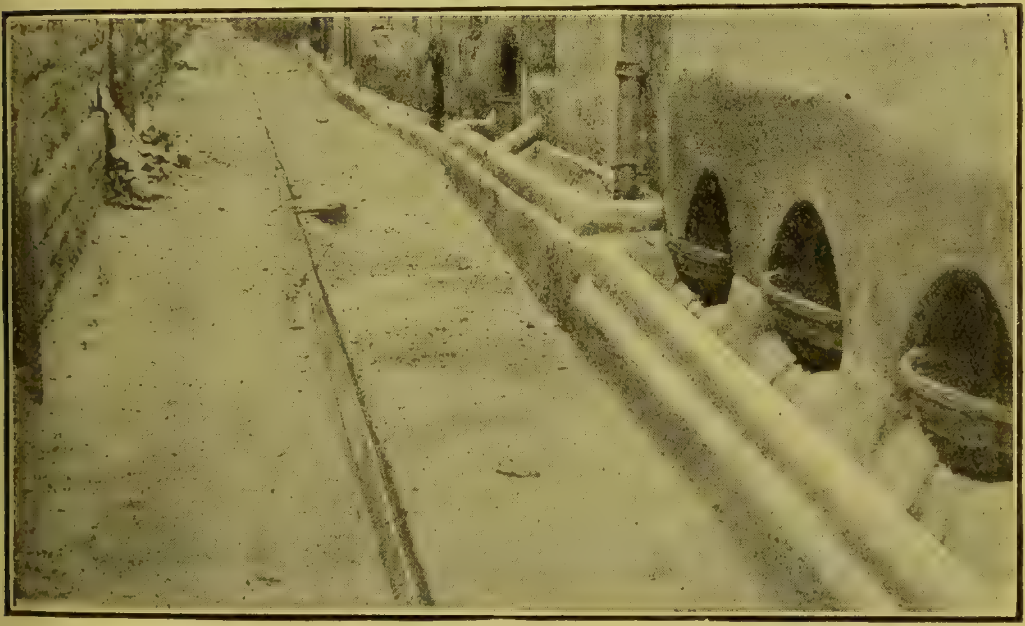
Bombay is the most sewered city in the East, that is to say, it has more sewers and more houses connected to the sewer and more water-closets.

At the same time there are thousands of houses with the old privy basket system; the basket is emptied twice daily, and the contents discharged into the sewer at the pail depôt. Between rows of houses a narrow sweeper's passage exists ranging from 1 foot to 5 feet wide. Houses of four and five stories abut on these passages, the living rooms opening on to them. The only ventilation many of the rooms have is from the filthy passages.

In Bombay, for conservancy purposes, 2 lbs. per head per day is the amount of night-soil and urine estimated to be removed from the native houses where privy receptacles are used, inclusive of ablution water and urine, much of the latter escaping into the open drains.

The halalkhor or sweeper or bhangi is an institution of tropical climates.

In sewered towns, where water-closets are not general and where the houses are not all connected with the sewer, the night-soil is collected by the halalkhor man or woman, from the privy receptacle, outside or inside the house, situated chiefly in a passage between two houses; it may be a commode in a bungalow or a public latrine in the street.



SWEEPER'S GULLY WITH BASKET PRIVIES AND OPEN DRAINS.

The privy receptacle is made of basket work or iron and holds about 15 lbs. of excreta.

The halalkhor basket holds roughly about 40 lbs. and when full is carried on the head some distance, varying from a few yards to a mile or more, and there deposited in the depôt connected with the sewers. The number of trips made by the halalkhor varies with the distance he has to travel to the depôt.

In streets, where the houses are close together, one man can collect and convey the contents of 30 privy receptacles; 3 receptacles go to a basket load. One receptacle may have to receive the excreta from 4 or 5 seats, according to the height and nature of the house, as the seats are placed one above the other in buildings of 4 and 5 stories, and 1 seat is considered sufficient for 20 persons. In Bombay it is found that one man can make 8 trips of ½ a mile each way, between 6 and 9 a. m. and 3 and 4 p.m., carrying 40 lbs. of night-soil, the work being estimated thus:—

In a temperate climate an average day's work is calculated to be 300 foot-tons.

A man weighing 150 lbs. and walking 17 miles on a level road at 3 miles an hour does 300 foot-tons.

A halalkhor weighing 120 lbs., carrying 40 lbs. on his head and making 8 trips in the morning and afternoon of ½ a mile per trip, would do about 150 foot-tons.

Let $W =$ weight of man.

$W_1 =$ weight carried.

$D =$ the distance walked in feet.

$C =$ co-efficient of traction $\frac{1}{20}$ at 3 miles an hour.

Then

$$\frac{(W + W_1) \times D}{2{,}240} \times C = \text{Foot-tons of work done}$$

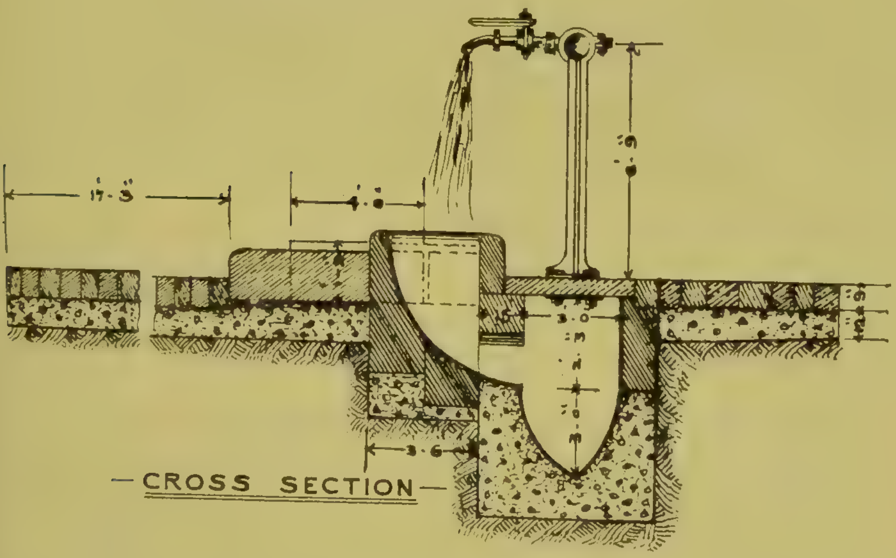
One man can thus remove the contents of 30 receptacles, making 8 trips of ½ a mile equal to 320 lbs., or the excreta from 80 persons in 3 hours, or 160 persons in a day's work.

The receptacle is placed on the ground-level, in a trap or compartment. (See figure on preceding page.)

The sweepers or halalkhors number about 2,800 men and women in Bombay City. The labour staff of the Health Department all told number 8,000. They muster at 5-30 a. m. and go round their beats collecting the night-soil, which they convey in baskets on their heads to the various depôts. If their work is not supervised and checked, they will scamp it either by making false trips or depositing the night-soil in the open drain. That the system is one of the greatest evils in the City cannot be denied. It costs in wages alone about Rs. 11,00,000 per annum without the cost of housing them.

The halalkhor, after 5-30 a. m. muster, takes his basket to his respective beat and loads it from the privy receptacle, which is made of basket-work, or iron in some cases. Immediately after emptying the receptacle, the privy trap is washed down, if water is available, or swept out with a broom. In the afternoon the same practice is gone through. The loaded basket is taken to the nearest pail depôt, where the contents are discharged into the hopper connected with the sewer and the waste washed out, and another trip made: the trip being marked, in a book kept for the purpose, by the trip marker. Sulphur is kept burning at these depôts.

—NIGHT SOIL DEPÔT—



In towns and districts which are not sewered, the same procedure is gone through, carts being the receptacles which convey the night-soil to the trenching ground.

(1) The capacity of a cesspool cart is 32 cubic feet. A cart will hold 200 gallons of cesspool water, or between 17 and 18 cwt.

(2) The average number of trips made by cesspool carts in districts is three for the whole day.

(3) As a rule there is one driver and one cart filler for each cart.

(4) The average distance each cart travels is nine miles a day.

(5) Hours of work are from 5-30 a.m. to 10 a.m. and 2 to 4 p.m. There is a certain number of carts employed at night between 7 and 11 p.m.

(6) On an average there are 25 privy cesspools to each cart and the average capacity of each cesspool is 20 cubic feet, but they vary according to the district.

In actual practice each cesspool is emptied every 3 days.

(7) The cost of repairs and maintenance and cartman's wages and of bullocks, per mensem, is as follows :—

(*a*) Repairs and maintenance : Rs. 4 per month per cart.

(*b*) Men's wages : driver Rs. 12 and filler Rs. 11-8 each per mensem.

(*c*) Bullocks : feeding and shoeing Rs. 18-8-0 and Rs. 2 per mensem, respectively.

In Bombay the Halalkhor Tax levied comes under four heads as follows :—

(*a*) Ordinary Halalkhor Tax, based on a 3 per cent. net valuation of the building or property.

(*b*) Special Halalkhor Tax for Mills at Re. 1 per head per annum on the number of employés in the mill or factory.

(*c*) Special Halalkhor Tax on Government, Port Trust and Railway properties, also Hotels, Messes and Clubs, as the Commissioner may direct. The tax in these cases is calculated and levied according to the Standing Committee's Resolution No. 6098, dated 2nd September 1891.

(*d*) Government properties used as residential quarters by their officials are charged the same as (*c*) but 8·6 per cent. reduction is allowed for casual vacancies.

In all the above cases reference is made to the Health Department in the case of ordinary service, in regard to rendering and discontinuing service. The same is the case with the Mills; the properties send in a return, every six months, of the number of their employès, and the tax is levied accordingly. In the last two cases, the Health Department gives details of service rendered and charges to be levied. These figures are checked by the Municipal Commissioner and the tax then recovered by the Assessment Department.

THE TRENCHING OF NIGHT-SOIL.

When properly carried out, the conversion of fresh night-soil into manure by burying it in trenches is one of the best systems known in India for small communities. Where-ever it is tried, the manure finds a ready sale.

The soil for effective trenching should be loamy and porous, and fairly well drained, and the section and depth of the trench must be of such dimensions as shall allow the process to be carried out without nuisance. Trenches vary from 2 feet deep and 2 feet wide. A mean of the two is preferable, 18 in. wide and 18 in. deep, which allows of cultivation and prevents breeding of flies and the action of the wind.

The dimensions will vary with the quality of the soil. The temperatures of the air and of the ground are favourable to the changes that take place during the process of conversion, and land that has been used for a period for trenching has its productiveness greatly increased.

Trenching is best suited for localities with a moderate rainfall, as the process of sewage removal will admit of no interruption.

At Nasik, the night-soil of the town (containing 33,463 inhabitants) is trenched in loamy soil in a manner that is both effective and profitable. The trenches are made about 18 inches wide and 18 inches deep, and of any desired length. They receive 12 inches of sewage, and are then covered up with earth. After a period of two or three weeks, the sewage is removed with part of the earth which it has saturated, and placed in a depôt for sale. It has now no offensive smell, and is readily purchased and used by cultivators.

At Poona, with a population of 117,256, the night-soil is collected in carts and trenched in the suburbs, in a manner similar to that in vogue at Nasik. During the process of burying it is mixed with ashes resulting from the burning of *cutchra*.

Trenching as carried on by digging pits is one of the worst methods of disposal of sewage. The urine and fæcal matter from public latrines and from depôts of night-soil, carried by scavengers from private houses, is transported in small tank carts of 12 cubic feet capacity to pits dug in the suburbs of the town on cultivable land. The pits are about 20 feet square and 4 feet deep, and are filled up with the liquid night-soil, which is left to heat up and ferment in the sun. If the ground is of clay, there is very little combination between it and the sewage, which putrefies so freely as to be covered like beer with a head of foam, due to the gas bubbles rising through it.

The stench is indescribable. The residue, when dry, is sold to cultivators as poudrette, the greater part of its fertilising power being lost in the gases of decomposition.

The trenches should not be located to windward of the town, and should not be within 300 yards of dwelling houses, tanks, or wells.

Major Harris, I.M.S., Sanitary Commissioner, United Provinces, gave an excellent description of the various methods of night-soil disposal and its association with fly breeding at the All-India Sanitary Conference at Madras, 1912.

To choose the best method, much depends on the site surroundings and soil, the chief object being transforming the night-soil as rapidly as possible into manure or utilising the land so treated for cultivation, with the minimum risk of fly breeding.

The various methods of night-soil disposal are :—

I. By separate septic tank installation for each latrine.

II. By incinerators.

III. The Thornhill system.

IV. The shallow trenching system.

V. The pitting system.

VI. The 2 feet deep trenching system.

VII. The method in small villages of deposition of excreta in the neighbouring fields.

VIII. The absorption or filter trench system, with removal of excreta to trenches.

IX. And, in addition, the methods in vogue at fairs :—

(*a*) The shallow pan system with removal of the solids to trenches.

(*b*) Defecation in open courtyard without pans but with a removal of the solids to trenches.

(*c*) In firm soil the shallow trench, 9 inches wide, 1 foot 6 inches deep, into which defecation is direct.

(*d*) In sandy loose soil the deep trench, into which the dejecta fall direct, but in which boards with supporting cross beams are placed to protect the edges of the trench from falling in by the weight of the user.

1. In the first system the installation is easy to work but the initial expense is large and the effluent is unfit to run into small streams and should be treated on land.

2. In incinerators we have an excellent method of disposal in towns, or parts of towns, where horse litter is obtainable or where the rubbish is of an inflammable character. The objections to the general use of incinerators are—

(*a*) That the rubbish in civil stations is usually of such a character that it will not burn well.

(*b*) That it is usually damp and in the rains very wet and requires long storage.

(*c*) That constant supervision is required.

(*d*) That no income accrues to the Municipality from the sale of rubbish and night-soil, although the expenses of cartage are diminished.

(*e*) The objection to the smell of incinerators.

3. The Thornhill system is the best method of earth disposal and does not lead to the breeding of flies, provided supervision is constant.
4. The pitting system is carried out in several ways. The most successful is by carrying the night-soil to pits in the fields of cultivators outside Municipal limits.

Another pitting method that is used is to fill up large 6 feet deep pits with solid night-soil, which is removed from the private latrines of the towns. When these pits are opened the stench is unbearable and fly larvæ are found to abound.

5. The shallow trenching system is carried out by placing the night-soil in trenches 9 inches deep and about 9 inches wide.

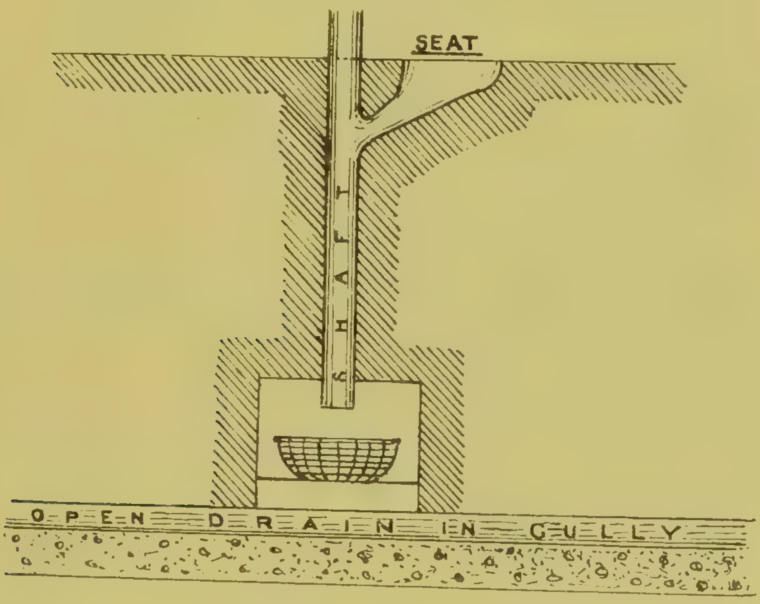
(1) A common method of disposal of night-soil in Municipalities is by trenching it in suitable trenches, and subsequently disposing of it to cultivators after it has remained a sufficient length of time in the ground. Trenches should be 2 feet broad and not more than 2 feet deep. A depth of 18 inches would be better, but economy generally demands the greater depth, which should however never be exceeded. These trenches should be dug in straight parallel lines, 2 feet apart from one another. Night-soil to the depth of 1 foot should be placed in them and the trenches then filled in with all earth taken out. They should, therefore, present the appearance of lines of mounds, the elevations indicating the site of the trenches. The earth will in a few months subside to the general ground level. Filth, thus trenched, will usually be resolved into harmless products after some six months' burial, but inasmuch as the rapidity with which such changes are effected depends largely upon the character of the soil, it is desirable in every case to ascertain, by an experimental excavation, whether the contents of a trench are dry and inodorous before the same are sold to cultivators and others.

The land taken up for trenching should be loamy or alluvial. Sandy soil should not be used for the purpose. A site once trenched should not be used for more than one year, or at the outside two years. After this time there will be no earth left to fill up the trenches over the night-soil deposited in them. The site should then be levelled and a few crops taken off it, when it can again be trenched. Urine is also best disposed of by trenching in a similar way.

(2) A second method is to trench as already described and then take a succession of exhausting crops off the land, such as vegetables, maize, tobacco, etc. Land thus treated can be trenched every year if the cultivation be complete and constant. The method, however, is not one which Municipalities are likely to adopt.

(3) The first object of course is to dispose of all impurities in a sanitary manner, so that the health of the community may be maintained. The various methods of doing this have been described above. In many cases, however, there is no sale for the resulting manure and thus it becomes lost. It should be the endeavour to utilize the manure thus, by taking up land where this is possible, and trenching on the shallow system and cropping with exhausting crops,

—OLD FORM OF BASKET PRIVY—



as potatoes and tobacco. This system was introduced by Col. Thornhill at Bareilly and consists in digging trenches 16′ × 5′ × 1′ with 6 inches between each trench and 6 inches between each line of trenches. The soil removed is thoroughly pulverized, an essential point, and 2 inches is returned to the trench into which the contents of one or two night-soil carts are tipped. If the night-soil is mixed with earth, the whole of the remaining earth need not be returned. A depth of 1 foot is necessary, as otherwise flies breed out in large quantities. Land so trenched does not require manuring again, usually till the fourth year.

In Cantonments a wet system of treatment has been tried. This consists of adding perchloride of mercury 1 to 500 or cresol, advocated by Lt.-Col. W. Morris, R.A.M.C., of Cawnpore ; the theory being the killing of the bacilli in the fæces and urine and subsequent disposal by incinerators.

EVOLUTION OF THE WATER-CLOSET.

The forms of privies and latrines commonly used may be classified into dry pattern and water-carriage.

In India there is no dry earth system as known in European cities ; it is rare to find outside Military Cantonments any form of privy in which dry earth or ashes are added to the excreta before removal.

In practice this method is found successful in public institutions where there is no sewage system. The important question is the addition of dried earth, 1 lb. each time the pail is used. In drying, the earth should not be heated so as to destroy nitrifying organisms which disintegrate the night-soil or humify it. The material must be tolerably dry. The action is aerobic.

The commonest method of getting rid of night-soil is that adopted by the inhabitants of villages and towns, who use the open fields or, at a sea-side place, the sea-shore.

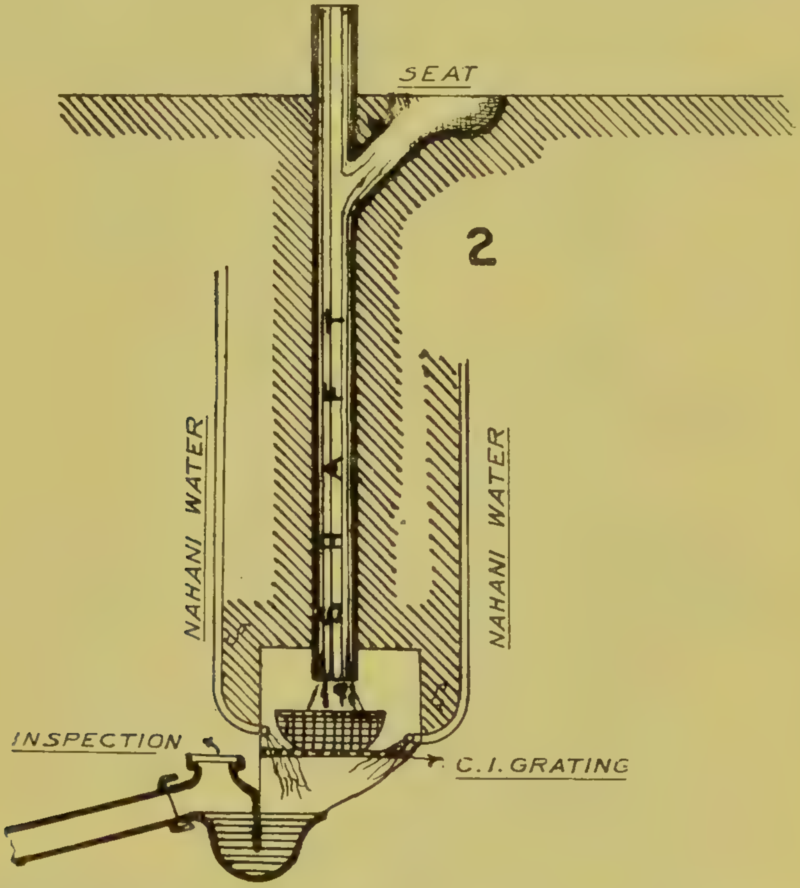
Trenches are cut in the ground into which earth is thrown after use.

The next step is the stone or earthen squat seat with or without a receptacle.

An improvement on this is the cemented platform on which the person squats, the urine and fæces being discharged on to a sloping shoot of iron or cement or glazed earthenware into a receptacle. Various patterns of these are on the market and much improvement has been made in them of late.

The receptacle may be of basket work, iron or earthenware.

It is the custom for the majority of natives of India to use ablution water and this adds to the quantity of matter to be removed.

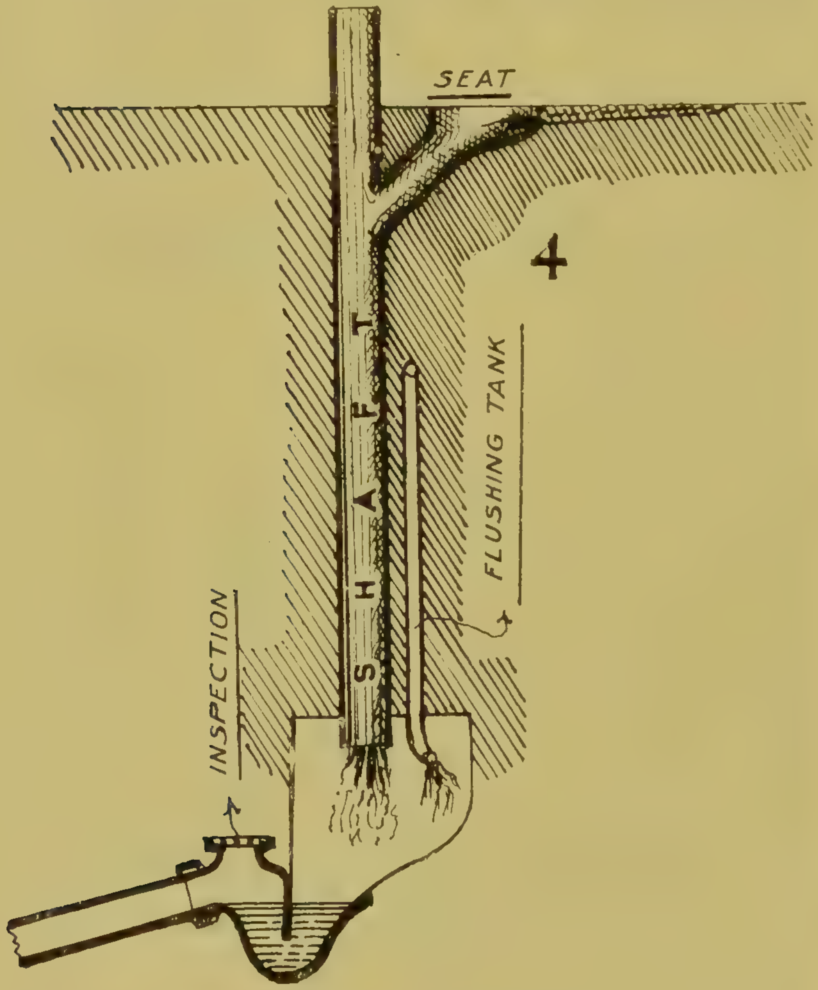


—IMPROVED FORM OF BASKET PRIVY—

Forms of seats and receptacles have been designed to separate the liquid from solid matter; this is desirable but rarely carried out. Fæces and urine combined decompose more readily than when separated.

The objects to be attained in providing privy accommodation in places where sewers do not exist are :

1. Position of latrines should be away from the buildings and to the lee-ward side.
2. Impervious floor and wall and seat or platform of impervious material.
3. Water-tight receptacles capable of holding the daily excreta of the household.



—MODIFIED WATER-CLOSET—

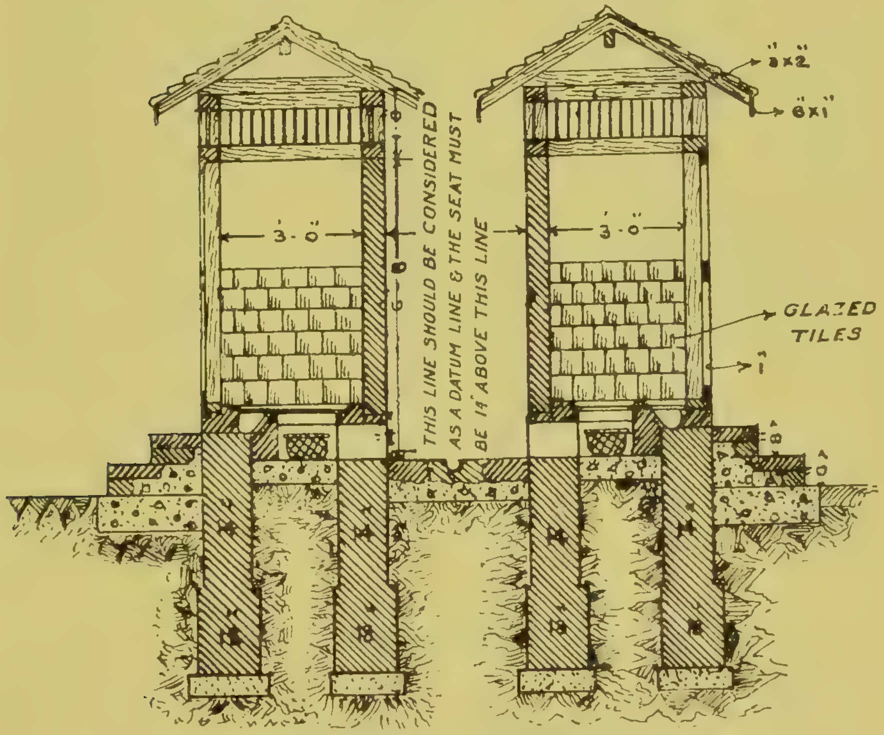
4. Facility of removal of contents once a day at least.
5. Ventilation of the privy.
6. Cleansing and disinfecting of receptacles.

In sewered towns where the latrines are not connected with the sewer, receptacles have to be provided and the contents removed to pail depôts by hand or carts.

The essence of practical sanitation in all countries is the immediate removal of all waste products. This should be more particularly the case in tropical countries, where decomposition sets in more rapidly.

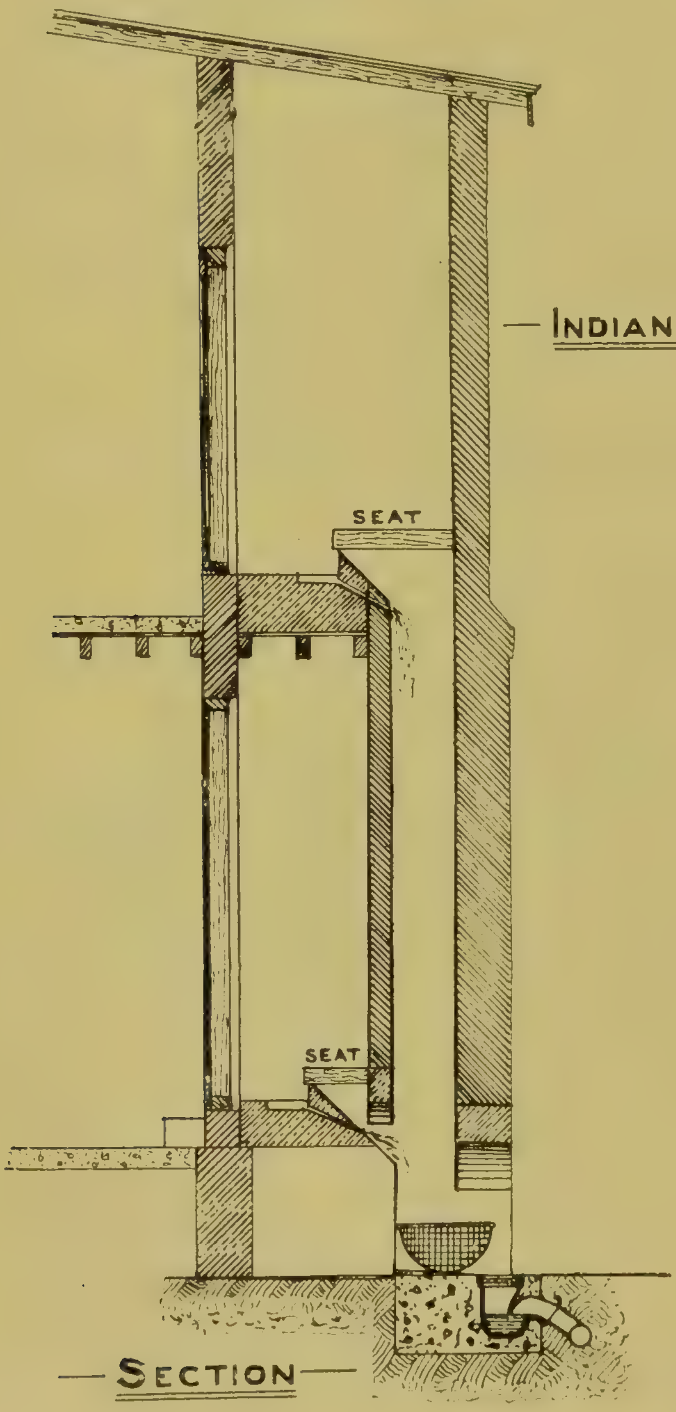
In towns, where the houses are built of two or more stories, the privy system is one of the most insanitary features of Indian life. In Bombay there are hundreds of houses in which privy seats are placed one above the other at one end of a dark passage within the building. The platform or seat is made of cement or stone or glazed earthenware discharging into an iron, earthen or stone shaft common to all the privies on the several floors. The excreta of all the tenants, numbering many hundred of persons in some of the chawls, is discharged into the shaft to drop into a small receptacle 30 to 60 feet below. The receptacle is placed in a

— BASKET SYSTEM PRIVY —


2"x2"
6"x1"
3-0"
3-0"
8"
THIS LINE SHOULD BE CONSIDERED AS A DATUM LINE & THE SEAT MUST BE 1½" ABOVE THIS LINE
GLAZED TILES
1"
8"
6"

— CROSS SECTION —

small square trap with a door, the contents solid and liquid overflow into the open drain between the rows of houses and are removed twice daily by the halalkhors. (*See* plate.) The shaft becomes coated with filth and the stench from the privy, which is often close to a living or cook room,



is very objectionable. The presence of the decomposing filth and water attracting flies and mosquitoes is a serious danger to health, apart from the constant foul smell and pollution of the air of the rooms.

To remedy this, when accommodation cannot for some reason be made on the full flushing system, an intermediate water carriage system was designed by Mr. C. C. James, late Drainage Engineer, Bombay Municipality, and improved modifications of this pattern are now being adopted.

The best form of intermediate water carriage closet is one with the soil pipe of glazed earthenware or iron coated with Barff's material or lead. The seat and basin is of glazed earthenware marble, tiles cerment or glass with a sharp slope to the soil pipe. The ablution water and fæce and urine are then discharged directly into the soil pipe.

The water-closet is placed close to the nahani or bathing place, the waste water from which flows into the basin. The soil pipe is carried up 5 feet above the eaves of the neighbouring houses; it discharges over a receptacle made of cement or glazed earthenware connected with the house drains, at the junction of which an inspection chamber is placed with a trap between the house and sewer. A 10-gallon automatic flushing tank is placed at the head of the house drain. No sewer air can then enter the house. While this is an improvement on the old form of privy it is not free from objections.

Comparison between a water-closet on the full flushing system and the intermediate water-closet.

In both cases the night-soil is discharged into the sewer.

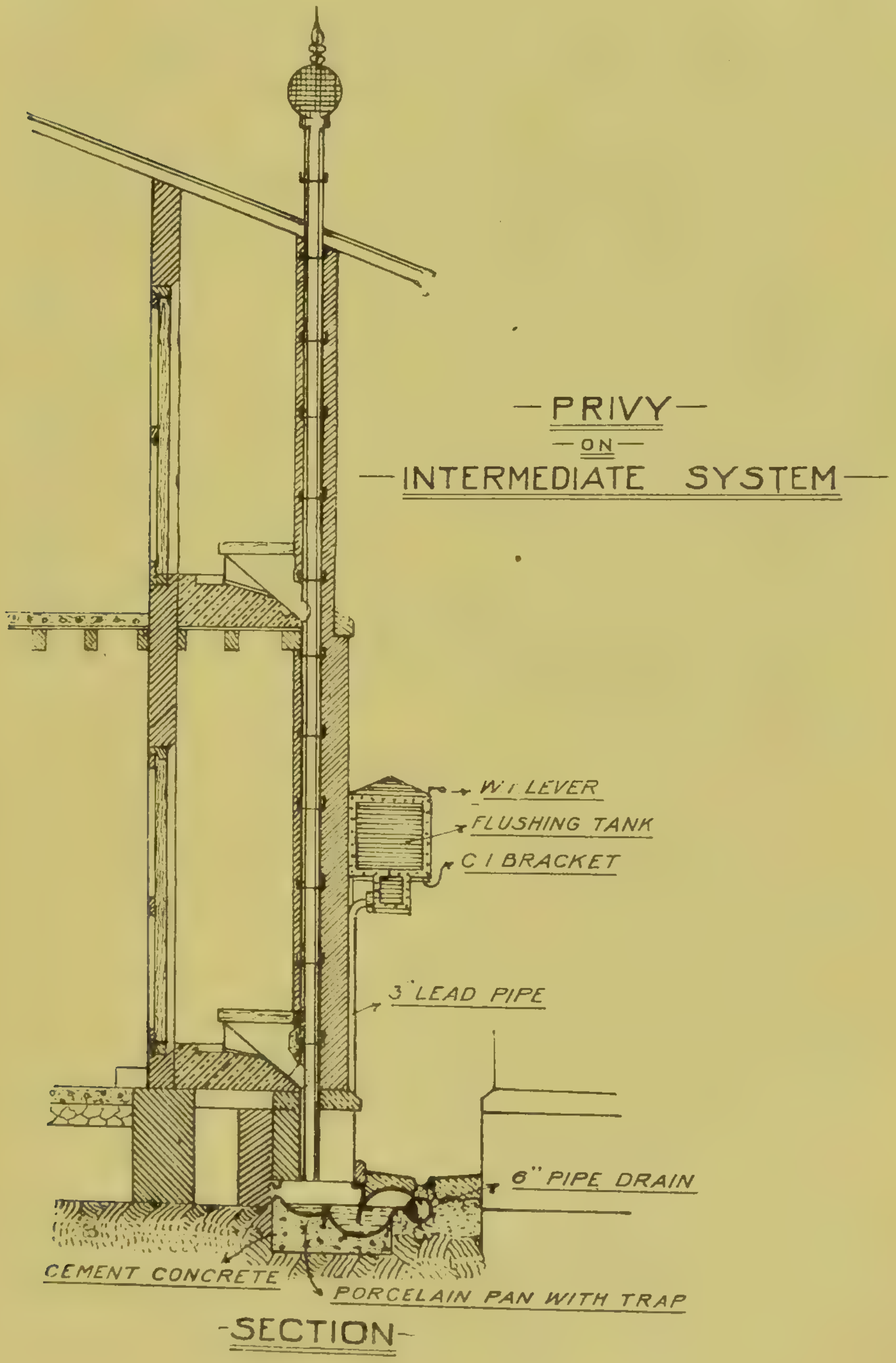
Full water-closet.	*Intermediate water-closet.*
The soil pipe is carried full bore above the eaves, and ventilates the house drain.	The soil pipe is carried up above the eaves and cut off from the receptacle below.
The house drain is disconnected from the sewer by means of inspection chamber and trap.	The soil pipe is flushed by the ablution water and the waste from the nahanies and bathing places.
At each water-closet seat there is a trap.	No sewer air can get into the house but the smell from

Sewer air cannot get into the house, if— (1) the traps are sealed ; (2) the inspection chamber is in order.	the fæces adhering to the pipe, if sufficient flushing is not adopted, will be a nuisance.
The cisterns are filled at least once a day and the basins are flushed.	The night-soil is discharged into a basin below on the ground level and is periodically flushed into the sewer through the house drain by a 15-gallon flushing tank discharging every 5 minutes ; the basin is trapped.
No night-soil remains in the pan and soil pipe if flushed.	
The advantage of this is that the night-soil is carried away immediately.	The advantage of this over the basket privy is that the night-soil is removed by water carriage into the sewer and not by hand though it is not all carried away at once and requires, in addition to the automatic flushing tank, a sweeper to clean and flush the basins.
	The smell from the decomposing filth of the privy seat and soil pipe is reduced, but unless the flushing is adequate and the soil pipe free from accumulation some smell is bound to remain. (*See* plate.) The advantages are that all the waste water is used to flush the soil pipe and basin and the house drain, while the automatic flushing tank forms an additional flush.

The gullies or places between the houses are dry and the open drains do not receive night-soil. The objectionable custom of removing the excreta by hand from the receptacle below is done away with. No night-soil remains for hours together polluting the air and making a breeding place for flies and vermin and the sight of the sweeper removing the basket of night-soil is avoided.

The next step is the water-closet on the full flushing system.

Much progress has been made in Bombay in this direction, as all new houses and all the newly built chawls for the



poorer classes have now such accommodation and the public latrines are for the most part on the water carriage system.

The argument that the water-closets get out of order and are not suitable to natives is over-done. A suitable form of water-closet with automatic flush and proper supervision is practicable in the majority of houses in large Indian towns.

The objections urged against water-closets in Indian towns are owing to :—

(1) the want of constant supply of water, (2) the habits of the Natives, (3) the inefficiency of the sewers and (4) the cost.

Without a proper supply of water, a water-closet connected with the sewer is undoubtedly not free from danger. But with a supply that is not on full pressure all the twenty-four hours, arrangements can be made to keep the water-closet properly supplied with water by providing suitable tanks and cisterns properly covered and fitted with automatic fittings and not directly connected with the water-closet. The size of the tanks necessary can be estimated by taking the census of the building, allowing for one day's supply and calculating 5 gallons per head per day for water-closet purposes.

Take a building of 100 rooms occupied by 4 persons each.

400 persons require 2,000 gallons per day for water-closet alone.

1 cubic foot of water is equal to 6·25 gallons.

Then 4 cisterns containing 500 gallons each placed on the highest part of the buiding would be sufficient, as each tank would measure 5′ × 4′ × 4′ or 80 cubic feet=500 gallons.

Cisterns.—Cisterns for supplying a water-closet should be separate from the storage tank and so constructed as not to deliver more than three gallons of water at a flush. They should be so made that it is impossible for water to enter whilst the flush is taking place or whilst the pull is drawn down. They should be supplied by means of ball taps and furnished with half-inch lead overflow or warning pipes.

No rod or pin used in the construction of water-closet cisterns should be of less than 5″ in diameter.

Every cistern to be used for the storage or reception of water should be made and at all times maintained absolutely water-tight, and supplied with a ball tap which must remain tight under a pressure of 150 lbs. per square inch ; the tap should be fixed so as not to become submerged when the cistern is full. The level of the water in the cistern should be maintained at two inches below the overflow or warning pipe, which must discharge in a prominent position so as to be easily seen by the Inspectors, and must on no account be connected with a drain. Cisterns should be so covered in as to exclude dust and mosquitoes, and be fitted with a man-hole for cleansing purposes and be capable of inspection. The supply pipe should have a draw-off tap, from which drinking water can be drawn before it enters the cistern. Cisterns should be of iron, slate or zinc, placed on the highest position of the building and protected from flies, rats and mosquitoes. No cisterns must be so placed that sewer gas can by any possibility have access to it.

Ball-cocks.—Where ball-cocks are employed they must be controlled by a stop-tap and must, where a meter is fixed, be of the equilibrium type, similar to Kennedy's No. E-106.

Practical Application.—It will be convenient at this point to discuss the application of these rules to the different classes of houses in cities and towns in India.

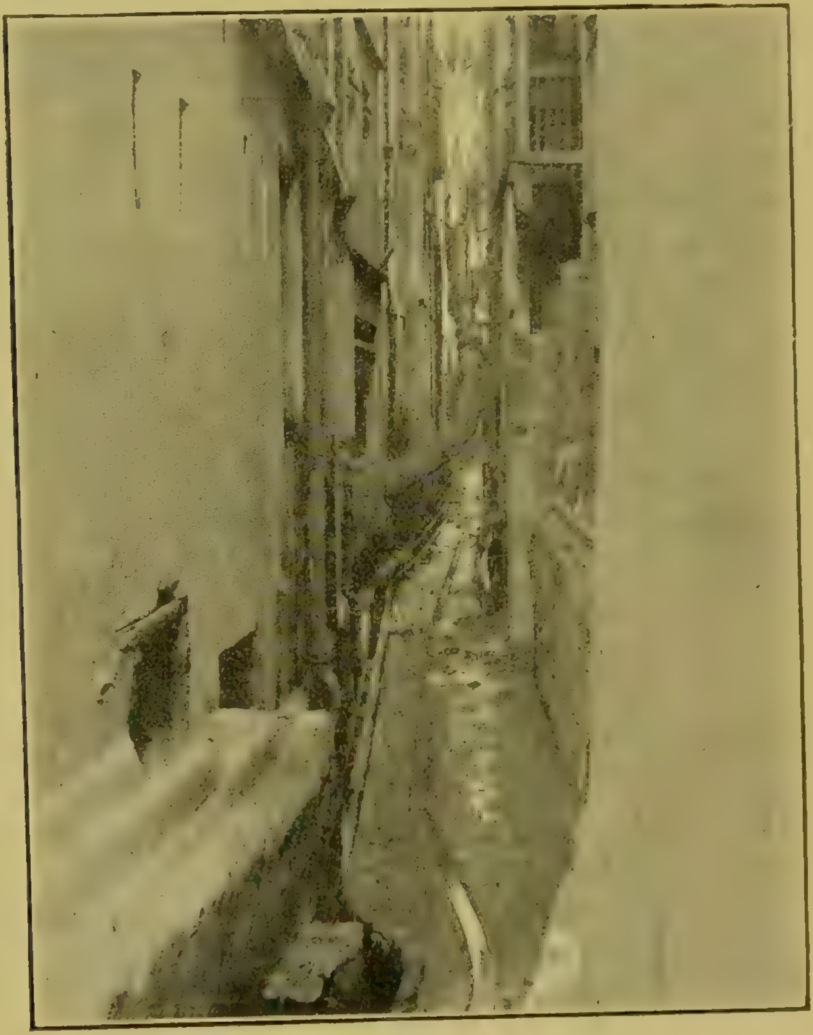
Reference has already been made to the various forms of privy accommodation, and how the excreta and sullage water are removed to the sewer. In many parts of every city in India there are no sewers available and recourse must be had to cesspits for sullage water.

Sullage water may be described as the waste water from cook rooms, bath rooms and nahanies, which does not necessarily contain excreta, though in India it would be difficult to eliminate fæcal matter as an ingredient of sullage.

The classes of houses to be met with are—

1. Those on European style with water-closets and baths, and drained and connected with the sewer on the modern system, as already described.

2. Bungalows with gardens occupied by Europeans or Indians.



The waste water from baths and stables and kitchens discharges into drains and sewers; the servants' water-closets are connected with the sewer, the tenants of the bungalows using commodes which are emptied by hand.

3. The native houses with water-closets and bathing accommodation separated from the houses, all connected with the sewer.

4. The native houses with nahanies inside the house, and the privy receptacle system, the contents being removed by hand; the waste water from bath, kitchen, nahani or mori overflowing from the privy receptacle discharges into covered pipe drains in the gully or passage between the houses, and into the house drains and sewer.

5. Similar houses but where the sullage and overflow from the privy receptacle pass into an open drain and then into the house drains and sewer.

6. The native houses on the privy receptacle system with a cesspit and sullage from the kitchen, nahani and bath discharging also into a cesspit. In this case the sullage water should be kept separate from the privy, and both cesspits should be emptied daily.

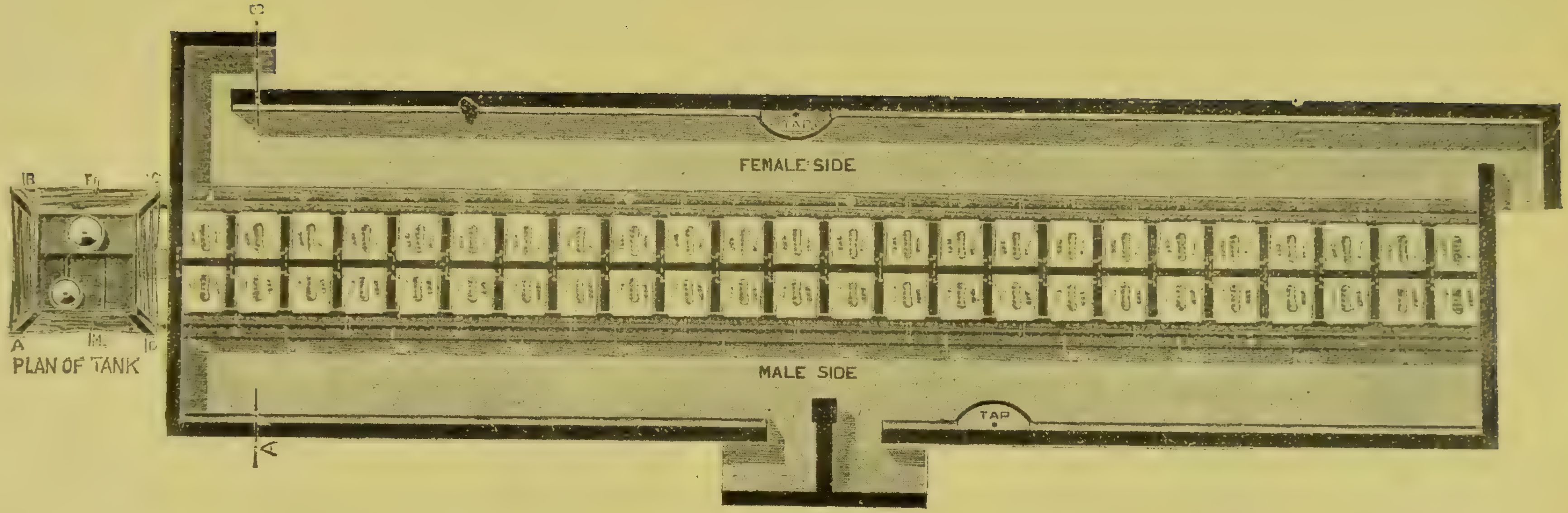
The Municipal Act provides that where there is a sewer within 100 feet of the premises, the owner must connect his drain with the sewer. Where there is no sewer within 100 feet, a cesspit must be provided into which the liquid from the privy receptacles and kitchen waste should discharge by means of a 4 inch pipe properly laid.

The capacity of a cesspit for houses of this kind in India should be sufficient to hold 24 hours' flow. The cesspit should be placed as far as possible from the dwellings, and ventilated with a 3 inch pipe, carried well above the highest window. The cesspit for privies should be separate from that for nahanies and should have a capacity of 3 cubic feet per privy seat, with a minimum of 10 cubic feet, and should be regularly emptied after 11 p.m. once in 24 hours. The cesspit should be constructed of brick laid on concrete and internally rendered with a ½ inch layer of cement and sand. Its walls should be brought up 6 inches above the surface of the ground, so that surface water should not be able to enter it, and covered with an air-tight cover to prevent noxious odour. Cesspits for sullage water from bath rooms should be similarly constructed, and if the water is used in the garden care should be taken to see that they are regularly emptied and properly covered, so as to prevent the breeding of mosquitoes.

The cleansing of house drains, gullies and waste water pipes in Bombay.—The Health Department undertakes this work, instead of reporting choked drains to the Drainage Department, and a special staff is appointed to carry it out under the control of the Chief Conservancy Inspectors. This work falls under the head of conservancy work, while at the same time it is an important part of the Sanitary Inspector's work as it is intimately connected with the sanitary arrangements of houses, a subject which the Sanitary Inspector is daily engaged on. All Sanitary Inspectors are expected to make it their duty to report on any defect in house drainage connections and assist the Drainage Inspectors.

The duties of the House Drainage Inspectors and Sub-Inspectors are to supervise the cleansing of house drains and waste water pipes and the opening of the same to remove chokes when necessary, and to serve notices on the landlords and recover expenses. Their duties do not cease here, as, in order to prevent daily chokes in drains, gully traps and waste water pipes, constant supervision of all gullies and drains is required and this includes the work of the muccadums, halalkhors, sweepers, begaris, plungermen and the throwing of kutchra from windows and for this purpose they can call in the assistance of any of the Conservancy Staff. The Sub-Inspectors, and muccadums especially, must be made to understand that they are to pay particular attention to the gullies and the way they are cleaned and to report chokes. The Drainage Inspector and Sub-Inspector will have frequent opportunities of noticing how the work of the halalkhors and sweepers is done, as in preventing chokes in drains much depends on the way the work is carried out.

The ordinary daily routine work is to inspect choked drains which have been reported and entered in the book kept at



Palmers Patent Mohalla Latrine Plan.

2 OTTO. 1955

their office and start the work of removing chokes and to proceed on a tour of inspection in their division. If the block cannot be removed at once notice must be served on the owners. Any drains found choked are to be noted and cleaned and the name of the muccadum of the particular section is to be taken down and entered in a book for reference, and inquiry made as to why the choke was not reported by him. When the house drain is free and the block occurs in the street connection, immediate notice is to be sent to the nearest Drainage Department office and confirmed afterwards by written intimation, copies of which should be kept in the usual way. All reports of choked or defective drains should be sent at once to the Inspector's office, entered in a book and attended to daily by the House Drainage Inspector. The Chief Inspector must see this book daily, sign it and send it to the Deputy Health Officer.

Books of Notices under Sections 260 and 257 are supplied to each Deputy Health Officer and notice under Section 260 must be sent to the Commissioner for signature when required.

PUBLIC LATRINES AND SANITARY CONVENIENCES.

The Municipal Acts in force in India lay down that the Sanitary Authority (see Section 252, Bombay Municipal Act) shall provide and maintain, in convenient situations, and on sites vesting in the Corporation, water-closets, latrines, privies and urinals, and other similar conveniences for public accommodation.

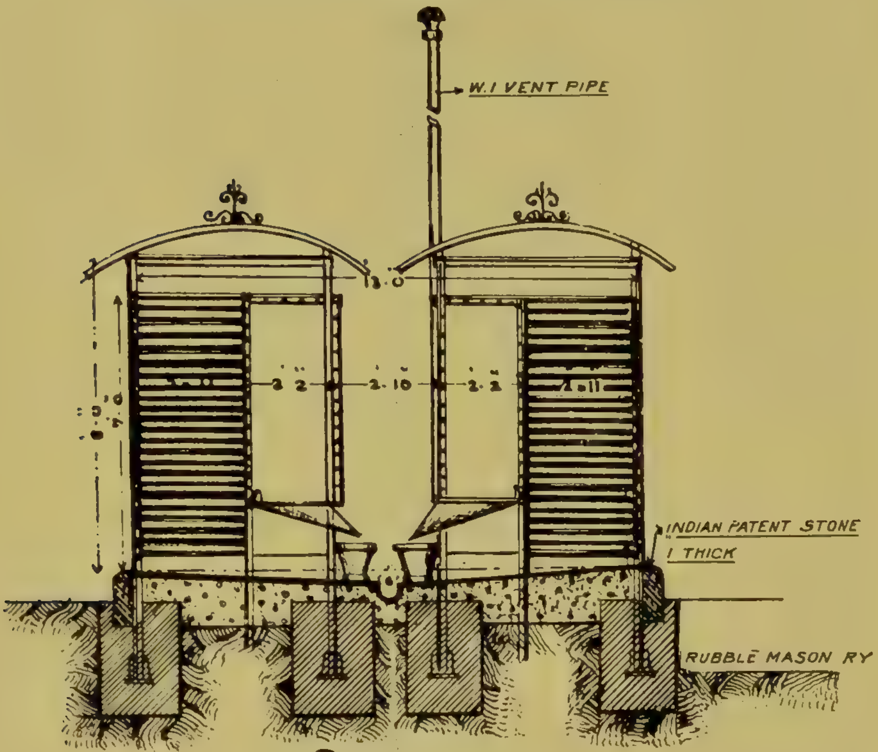
It devolves on the Health Department, as a rule, to advise on the number, site, capacity and form of public conveniences, and in doing this the following points have to be considered :—

In very few cities in India is it possible to have a latrine for every house.

The Act empowers the Sanitary Authority to insist on the provision of privy accommodation for each house. The

Bombay and Calcutta Municipal Acts do so, and the Public Health Act, England, 1875, but with modifications. For example, if the privy accommodation, already provided, is common to several houses and is sufficient or if there is sufficient Municipal accommodation available in the neighbourhood, the Sanitary Authority need not insist on separate accommodation for each house. These circumstances

—CRAWFORD SYSTEM LATRINES—



—SECTION—

then have to be considered, and to meet the requirements of the people it will be necessary to decide what Municipal public accommodation is required for different localities—

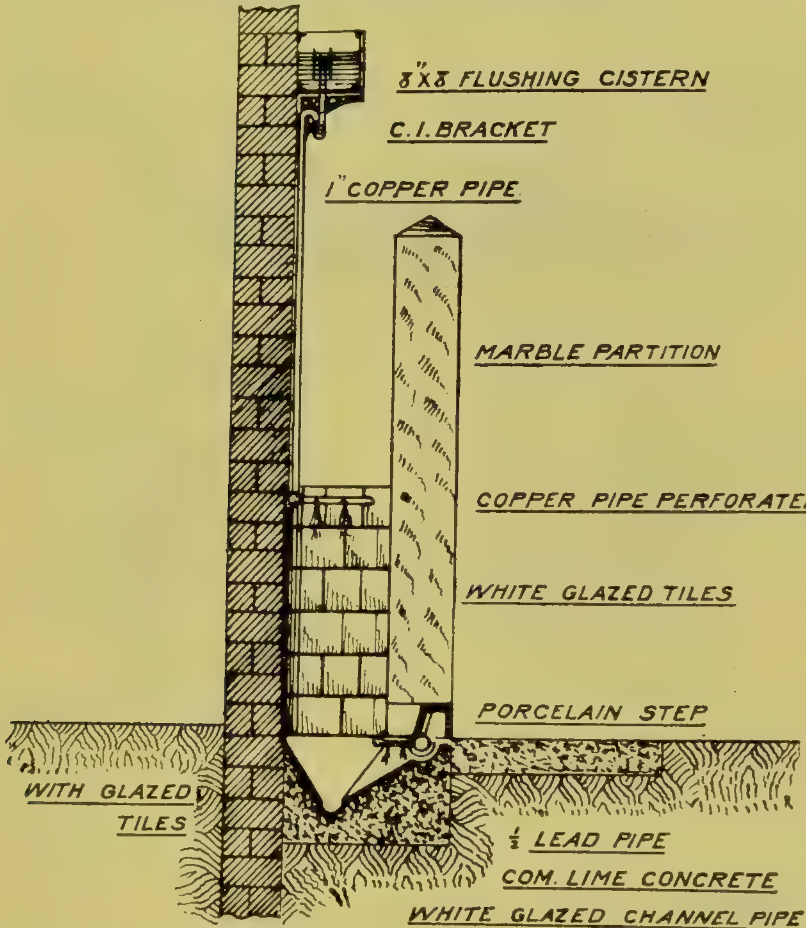
1. Where no drains and sewers are available and the night-soil has to be carried to a trenching ground.

2. Where sewers are available but water is not sufficient for a constant supply at full pressure, and the night-soil has to be carried to the pail depôt.

3. Where the water closets can be on the full flushing system.

Amongst the poorer classes, in mill districts, Docks and localities occupied by daily labourers, the houses are provided with latrines common to the houses or chawls.

—COMBINED CONSTANT FLUSHING URINAL—
—PLACED IN A CORNER—

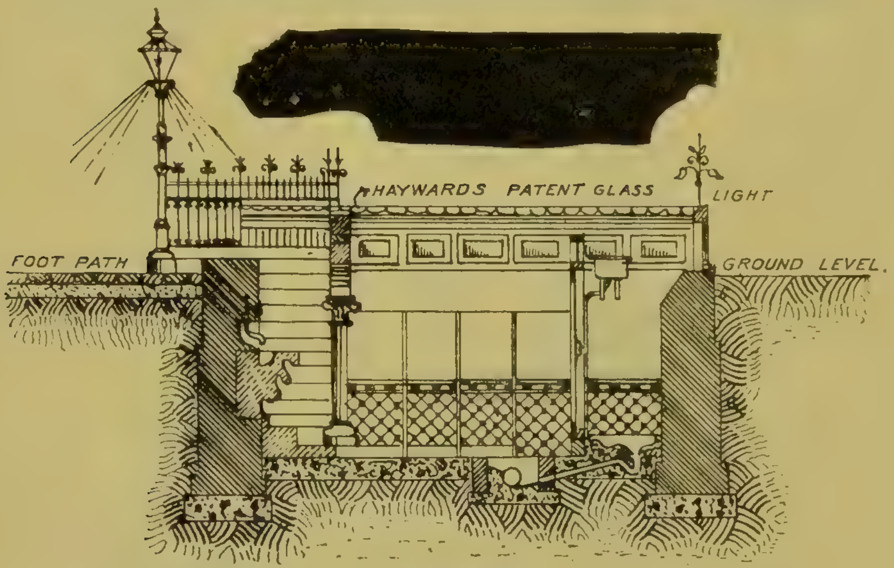


—VERTICAL SECTION—

Mills and factories must provide latrines in some form or other.

The early hours of the morning, from 4 to 8, are the time when the latrines are most used, and, as there will be a rush for the latrines in the compounds of the houses, public latrines will be in demand. A visit to a latrine will probably take 4 minutes, therefore 15 persons can use one seat every hour, or 60 in the first 4 hours; and on this basis, 15 seats will be sufficient for a population of 1,000, because the whole population would not require to use them at the same time. but only those who cannot be accommodated at their houses or works. For large blocks of labourers' dwellings, or mills or factories, more accommodation is required, and in Bombay it is usual to ask for 1 seat for every five rooms, or 20 persons in a chawl, house or mill, and although there is no bye-law to that effect, it has been so long the custom that it is now recognised by architects and the Magistrates' Court. In the Factory Act, 1 seat for 50 persons is laid down, but this is not sufficient unless on the water carriage system even when separate urinals are provided.

— COMBINED UNDERGROUND PUBLIC CONVENIENCES —



— SECTION —

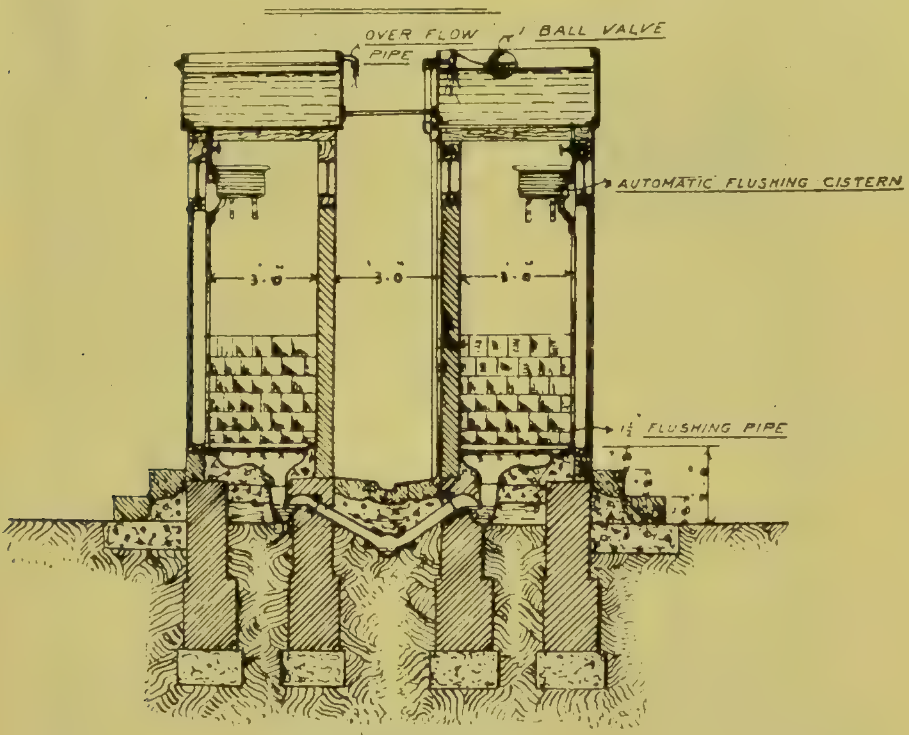
Public latrines and urinals should be provided at suitable places, for example, outside theatres, the neighbourhood of Docks and Railway stations, Tram terminus, Burial grounds and markets, &c., stables and large blocks of dwellings.

Public conveniences on the water carriage system should be tiled inside and paved outside for a distance of 6 ft. all round, and provision made for washing the surrounding pavement.

No matter what accommodation is provided, fouling of the roads in the neighbourhood of latrines and urinals always takes place in India. The inside of urinals and latrines is not only misused, but the outside as well.

It is a very common thing to see in all the large cities in India, urinals without any screen in the most thickly populated streets, and although the question of decency may not be so important in the mind of the uneducated native, there is no reason why this practice should be allowed. The reasons why these screens are omitted is to prevent them being misused.

—IMPROVED WATER CARRIAGE LATRINES—



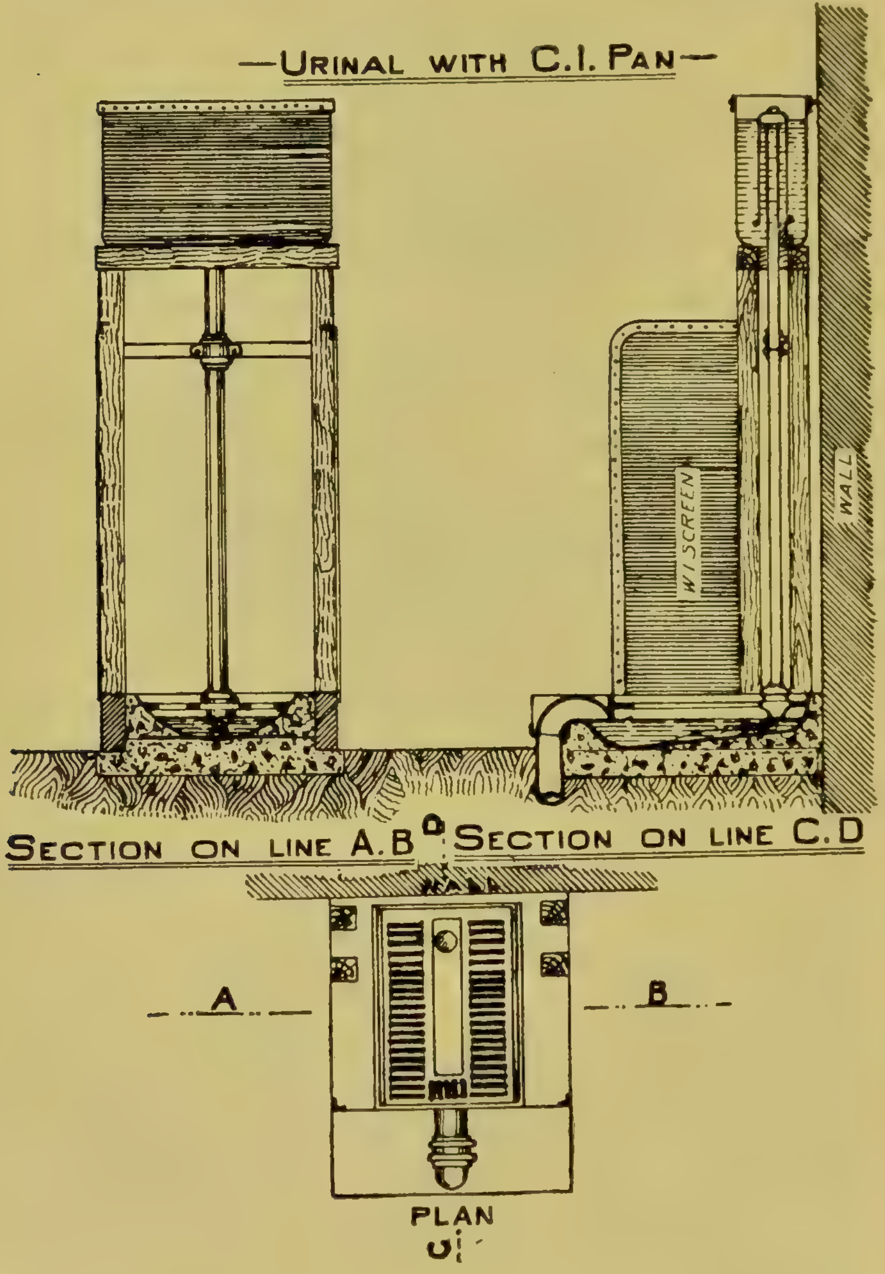
—CROSS SECTION—

The principles underlying all regulations for sanitary fittings are the prevention of foul air or liquid escaping from the house drain or sewer into dwellings or open space close to dwellings, and the thorough ventilation of soil pipes, drains and sewers. For this purpose strict regulations have been drawn up.

The bye-laws in force in the London County Council and in the Bombay Municipality are given below.

It must be understood that the condition of the two Cities varies greatly. In India the Building and Drainage regulations are not so complete as in England, though they are gradually becoming so in Bombay and Calcutta. At the same time conditions exist, due to climate and the habits and customs of the people and the water supply, which

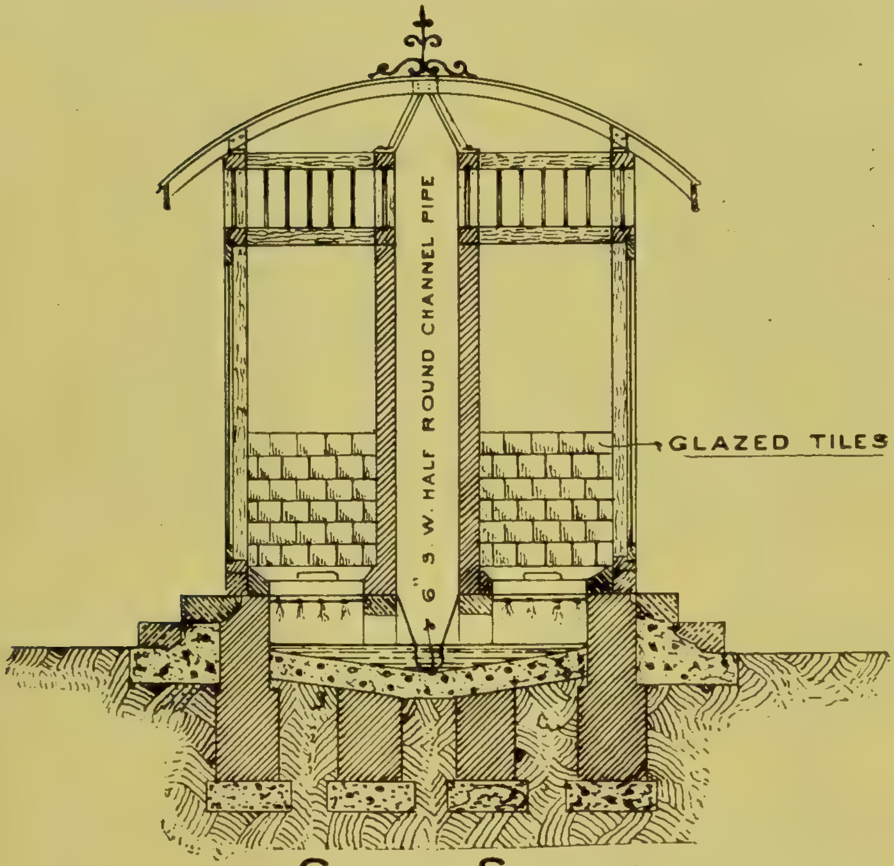
—URINAL WITH C.I. PAN—



have to be competed against and a knowledge of these is necessary for the proper understanding of the regulations in force.

The rules as to how the water-closet should be fixed should not vary.

—TROUGH PATTERN LATRINES—



—CROSS SECTION—

The fittings of a completely fitted water-closet should be the same everywhere and the sketch given is of the most modern type, and the instructions as to connection the most up-to-date.

To meet demands and to prevent nuisance, many modified forms of water-closets are adopted in India.

London County Council Requirements.

(*Extracts from By-laws made by the London County Council under the Public Health (London) Act,* 1891.)

Water-closets.—Every person who shall hereafter construct a water-closet shall construct it in such a position that one of its sides at the least shall be an external wall, which external wall shall abut immediately upon the street, or upon a yard, or garden, or open space of not less than 100 square feet of superficial area, measured horizontally at a point below the level of the floor of such closet. He shall not construct any such water-closet so that it is approached directly from any room used for the purpose of human habitation, or used for the manufacture, preparation, or storage of food for man, or used as a factory, workshop, or work-place.

He shall construct such water-closet so that on any side on which it would abut on a room intended for human habitation, or used for the manufacture, preparation, or storage of food for man, or used as a factory, workshop, or work-place it shall be enclosed by a solid wall or partition of brick or other materials, extending the entire height from the floor to the ceiling.

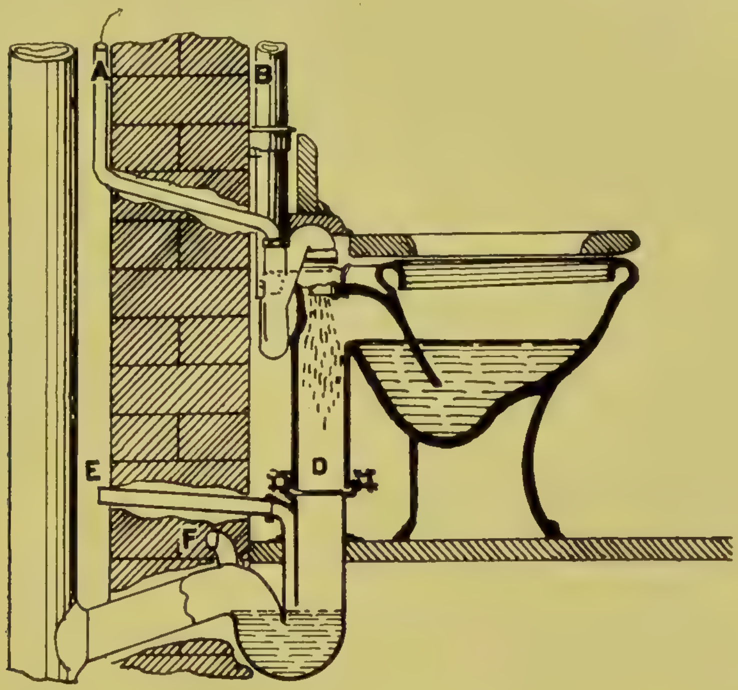
He shall provide any such water-closet that is approached from the external air with a floor, of hard, smooth, impervious material, sloping to the door half-an-inch to the foot.

He shall provide such water-closet with proper doors and fastenings.

Every person who shall construct a water-closet in connection with a building, whether the situation of such water-closet be or be not within or partly within such building, shall construct in one of the walls of such water-closet which shall abut upon the public way, yard, garden, or open space, as provided by the preceding by-law, a window of such dimensions that an area of not less than two square feet, which may be the whole or part of such window, shall open directly into the external air.

He shall, in addition to such window, cause such water-closet to be provided with adequate means of constant ventilation by at least one air brick built in an external wall of such water-closet or by an air shaft or by some other effectual method or appliance.

Every person who shall construct a water-closet in connection with a building shall furnish such water-closet with a cistern, of adequate capacity for the purpose of flushing, which shall be separate and distinct from any cistern used for drinking purposes and shall be so constructed, fitted and placed as to admit of the supply of water for use in such water-closet, so that there shall not be any direct communication between any service pipe upon the premises and any part of the apparatus of such water-closet other than such flushing cistern.



—JENNINGS PATENT CLOSET OF THE CENTURY—

Provided always that the foregoing requirement shall be deemed to be complied with in any case where the apparatus of a water-closet is connected for the purpose of flushing with a cistern of adequate capacity which is used solely for flushing water-closets or urinals.

He shall construct or fix the pipe and union connecting such flushing cistern with the pan, basin or other receptacle with which such water-closet may be provided, so that such pipe and union shall not in any part have an internal diameter of less than one inch and a quarter.

He shall furnish such water-closet with a suitable apparatus for the effectual application of water to the pan, basin of other receptacle with which such apparatus may be connected and used, and for the effectual flushing and cleaning or such pan, basin or other receptacle, and for the prompt and effectual removal therefrom and from the trap connected therewith of any solid or liquid filth which may from time to time be deposited therein.

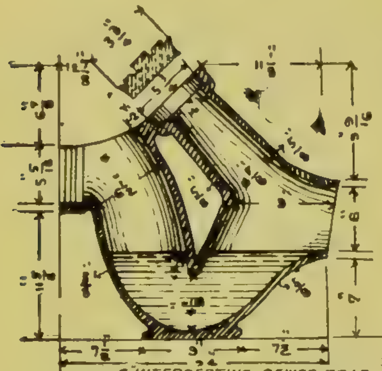
He shall furnish such water-closet with a pan, basin or other suitable receptacle of non-absorbent material, and of such shape, of such capacity, and of such mode of construction as to receive and contain a sufficient quantity of water and to allow all filth which may from time to time be deposited in such pan, basin or receptacle, to fall free of the sides thereof and directly into the water received and contained in such pan, basin or receptacle.

He shall not construct or fix under such pan, basin or receptacle any "container" or other similar fitting.

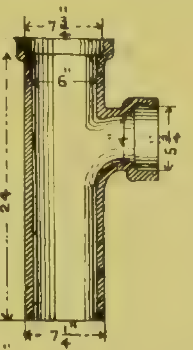
He shall construct or fix immediately beneath or in connection with such pan, basin or other suitable receptacle, an efficient siphon trap, so constructed that it shall at all times maintain a sufficient water seal between such pan, basin or other suitable receptacle and any drain or soil pipe in connection therewith. He shall not construct or fix in or in connection with the water-closet apparatus any D trap or other similar trap.

Any person who shall provide a soil pipe in connection with a new building for the purpose of conveying to a sewer any solid or liquid excremental filth, or shall for that purpose construct a soil pipe in connection with an existing building, shall, whenever practicable, cause such soil pipe to be situated outside such building, and shall construct

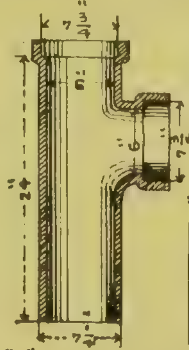
DIMENSIONED SKETCHES OF THE PIPES FITTINGS &c.



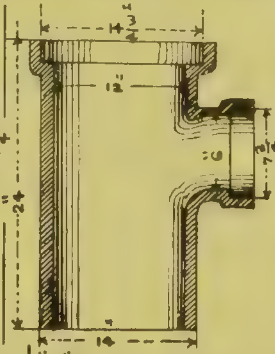
6" INTERCEPTING SEWER TRAP



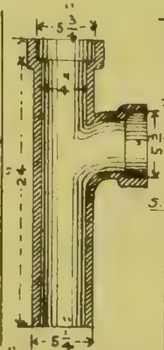
6"X4" S.W. QUADRANT JUNCTION



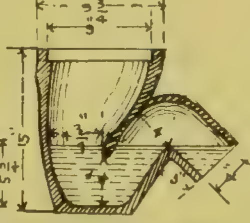
6"X6" QUADRANT JUNCTION



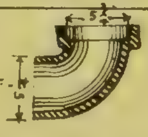
12"X8" QUADRANT JUNCTION



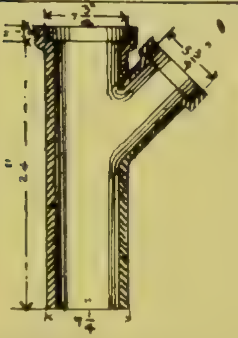
4"X4" S.W QUADRANT JUNCTION



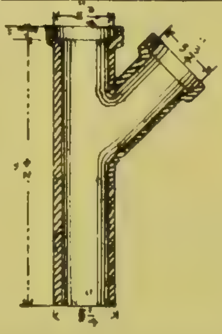
S.W. GULLY TRAP 9"X9" WITH 4" OUTLET



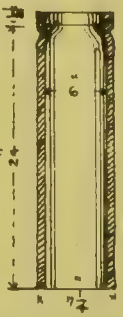
4" S.W. KNUCKLE BEND



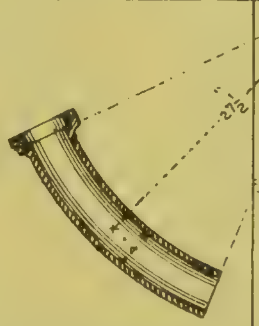
6"X4" S.W. OBLIQUE JUNCTION



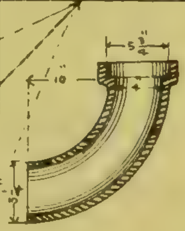
4"X4" S.W. OBLIQUE JUNCTION



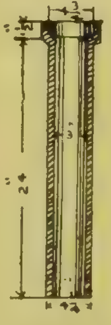
6"X4" S.W. TAPER PIECE



4" S.W. SEGMENTAL BEND



4" S.W. QUADRANT BEND



5" S.W PIPE

such soil pipe in drawn lead or of heavy cast iron. Provided that in any case where it shall be necessary to construct such soil pipe within such building he shall construct such soil pipe in drawn lead with proper wiped plumbers' joints, and so as to be easily accessible.

He shall construct such soil pipe, whether inside or outside the building, so that its weight, if the pipe be of lead, and its thickness and weight if the pipe be of iron, in proportion to its length and internal diameter shall be—

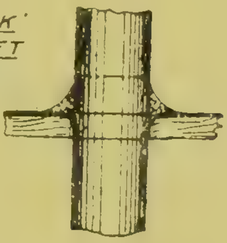
Lead.		*Iron.*	
Diameter.	*Weight per 10 ft. length not less than*	*Thickness of metal not less than*	*Weight per 6 ft. length (including socket and beaded spigot or flanges, the socket not to be less than ¼ in. thick) not less than*
1	2	3	4
3½ inches ...	65 lbs.	3-16 inch.	48 lbs.
4 ,, ...	74 ,,	3-16 ,,	54 ,,
5 ,, ...	92 ,,	¼ ,,	69 ,,
6 ,, ...	110 ,,	¼ ,,	84 ,,

If he shall construct such soil pipe of cast iron with socket joints, he shall cause such joints to be not less than 2½ inches in depth and to be made with molten lead properly caulked, and he shall also cause the annular space for the lead in the case of 3½ inch and 4 inch pipes to be not less than ¾ inch in width, and in the case of 5 inch and 6 inch pipes to be not less than $\frac{3}{6}$ inch in width. If he shall construct such soil pipe with flange joints he shall cause such joints to be securely bolted together with some suitable insertion.

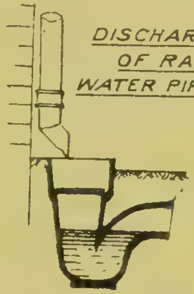
He shall construct such soil pipe, whether inside or outside the building, so that it shall not be connected with any rain-water pipe or with the waste of any bath, or of any sink other than that which is provided for the reception of urine or other excremental filth, and he shall construct such soil pipe so that there shall not be any trap in such soil pipe or between the soil pipe and any drain with which it is connected.

He shall cause such soil pipe, whether inside or outside the building, to be circular and to have an internal diameter of not less than 3½ inches, and to be continued upwards without diminution of its diameter, and (except where unavoidable) without any bend or angle being formed in such soil pipe, to such a height and in such a position as to afford by means of the open end of such soil pipe a safe outlet for foul air.

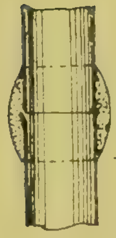
BLOCK OR TAFT JOINT



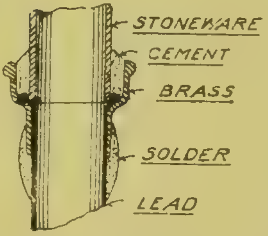
DISCHARGE OF RAIN-WATER PIPE

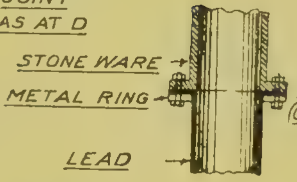


WIPED SOLDER JOINT AS AT D

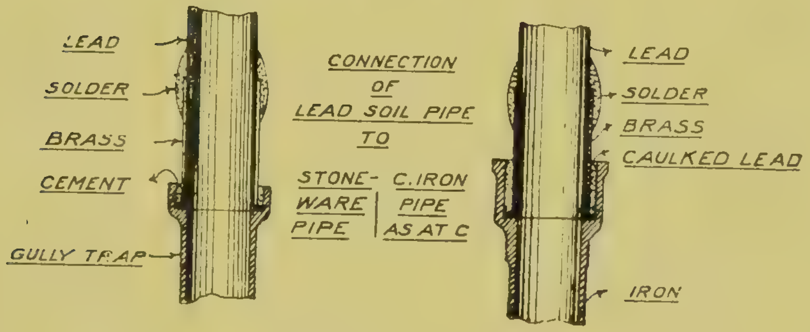


JOINT BETWEEN STONEWARE OUTLET OF CLOSET AND LEAD SOIL PIPE AS AT A





JOINT BETWEEN STONEWARE OUTLET OF CLOSET AND LEAD SOIL PIPE (OR OF FLANGED IRON PIPE TO LEAD PIPE AS AT B)



CONNECTION OF LEAD SOIL PIPE TO STONE-WARE PIPE | C. IRON PIPE AS AT C

Any person who shall connect a lead soil pipe, waste pipe, ventilating pipe or drain communicating with the sewer, shall insert between such lead soil pipe, waste pipe, ventilating pipe or trap, and such iron pipe or drain, a flanged thimble of copper, brass, or other suitable alloy, and shall connect such lead soil pipe, waste pipe, ventilating pipe, or trap with such thimble by means of a wiped or overcast metallic joint, and shall connect such thimble with such iron pipe or drain by means of a joint made with molten lead properly caulked; provided always that it shall be sufficient if he shall connect the lead soil pipe, waste pipe or ventilating pipe, or trap with the iron pipe or drain in an equally suitable and efficient manner.

Any person who shall connect a stoneware or semi-vitrified ware trap or pipe with a lead soil pipe, waste pipe or trap communicating with a sewer, shall insert between such stoneware or semi-vitrified ware trap or pipe and such lead soil pipe, waste pipe or trap, a socket of copper, brass, or other suitable alloy, and shall insert such stoneware or semi-vitrified ware trap or pipe into such socket, making the joint with Portland cement, and shall connect such socket with the lead soil pipe, waste pipe, or trap, by means of a wiped or overcast metallic joint; provided always that it shall be sufficient if he shall connect the stoneware or semi-vitrified ware trap or pipe with the lead soil pipe, waste pipe or trap, in an equally suitable and efficient manner.

Any person who shall connect a lead soil pipe, waste pipe, ventilating pipe, or trap with a stoneware or semi-vitrified ware pipe or drain communicating with a sewer shall insert between such lead soil pipe, waste pipe or ventilating pipe, or trap and such stoneware, or semi-vitrified ware pipe or drain, a flanged thimble of copper, brass, or other suitable alloy and shall connect such lead soil pipe, waste pipe, ventilating pipe, or trap with such thimble by means of a wiped or overcast metallic joint, and shall insert the flanged end of such thimble into a socket of such stoneware or semi-vitrified ware pipe or drain making the joint with Portland cement; provided always that it shall be sufficient if he shall connect the lead soil pipe, waste pipe, ventilating pipe, or trap with the stoneware or semi-vitrified ware pipe or drain in an equally suitable and efficient manner.

Any person who shall connect an iron soil pipe, ventilating pipe, or trap with a stoneware or semi-vitrified ware pipe or drain communicating with a sewer, shall insert the beaded spigot end of such iron soil pipe, waste pipe, ventilating pipe, or trap into a socket of such stoneware or semi-vitrified ware pipe or drain making the joint with Portland cement; provided always that it shall be sufficient if he shall connect the iron soil pipe, waste pipe, ventilating pipe, or trap with the stoneware or semi-vitrified ware pipe or drain in an equally suitable and efficient manner.

Any person who shall connect a stoneware or semi-vitrified ware trap or pipe with an iron soil pipe, waste pipe, trap or drain communicating with a sewer, shall insert such stoneware or semi-vitrified ware trap or pipe into a socket of such iron soil pipe, waste pipe, trap or drain, making the joint with Portland cement; provided always that it shall be sufficient if he shall connect the stoneware or semi-vitrified ware trap or pipe with the iron soil pipe, waste pipe, or drain in an equally suitable and efficient manner.

Any person who shall construct any water-closet the soil pipe of which shall communicate with any sewer, and shall be in connection with any other water-closet shall cause the trap of every such water-closet to be ventilated into the open air at a point as high as the top of the soil pipe, or into the soil pipe at a point above the highest water-closet connected with such soil pipe and so that the ventilating pipe shall have in all parts an internal diameter of not less than 2 inches and shall be connected with the arm of the soil pipe or trap at a point not less than 3 and not more than 12 inches from the highest part of the trap and on that side of the water seal which is nearest to the soil pipe. He shall cause the joint between the ventilating pipe and the arm of the soil pipe or the trap to be made in the direction of the flow.

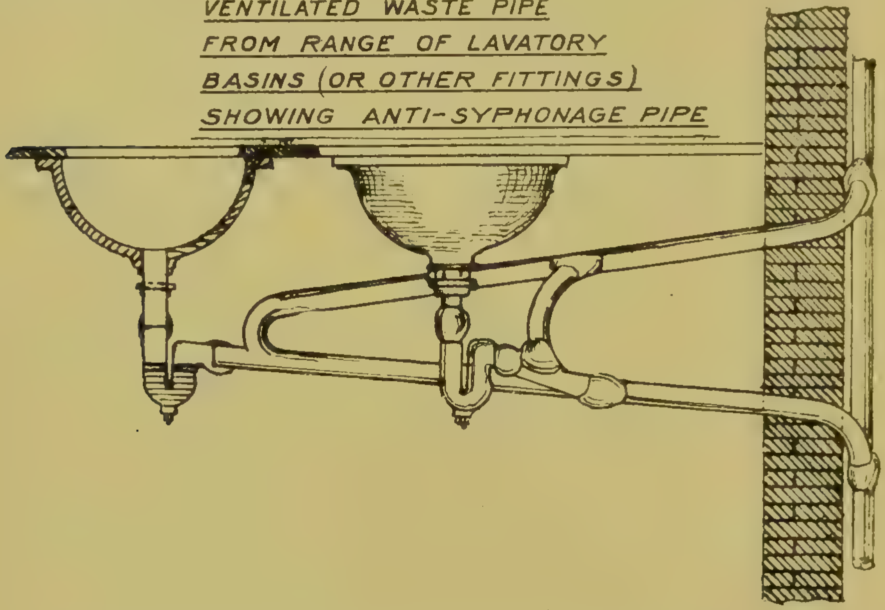
He shall construct such ventilating pipe in drawn lead or heavy cast iron. Provided that in any case where it shall be necessary to construct such ventilating pipe within a building he shall construct such ventilating pipe in drawn lead.

He shall construct such ventilating pipe, whether inside or outside a building, so that if the pipe be of lead its weight shall not be less than 25 lbs. per 6 feet length.

He shall in all cases cause the joints in and the connections to such ventilating pipe to be made in the same manner as if such ventilating pipe were a soil pipe.

A person who shall erect a new building and shall construct in connection with such building a slop sink or urinal constructed or adopted to be used for receiving any solid or liquid excremental filth or conveyance to any sewer, shall construct or fix immediately beneath such slop sink or urinal an efficient syphon trap, so constructed as to be capable of maintaining a water seal between such slop sink or urinal and any drain, soil pipe or waste pipe in connection therewith. He shall not construct or fix in or in connection with such slop sink or urinal any trap of the kind known as a bell-trap, a dip-trap, or a D-trap..

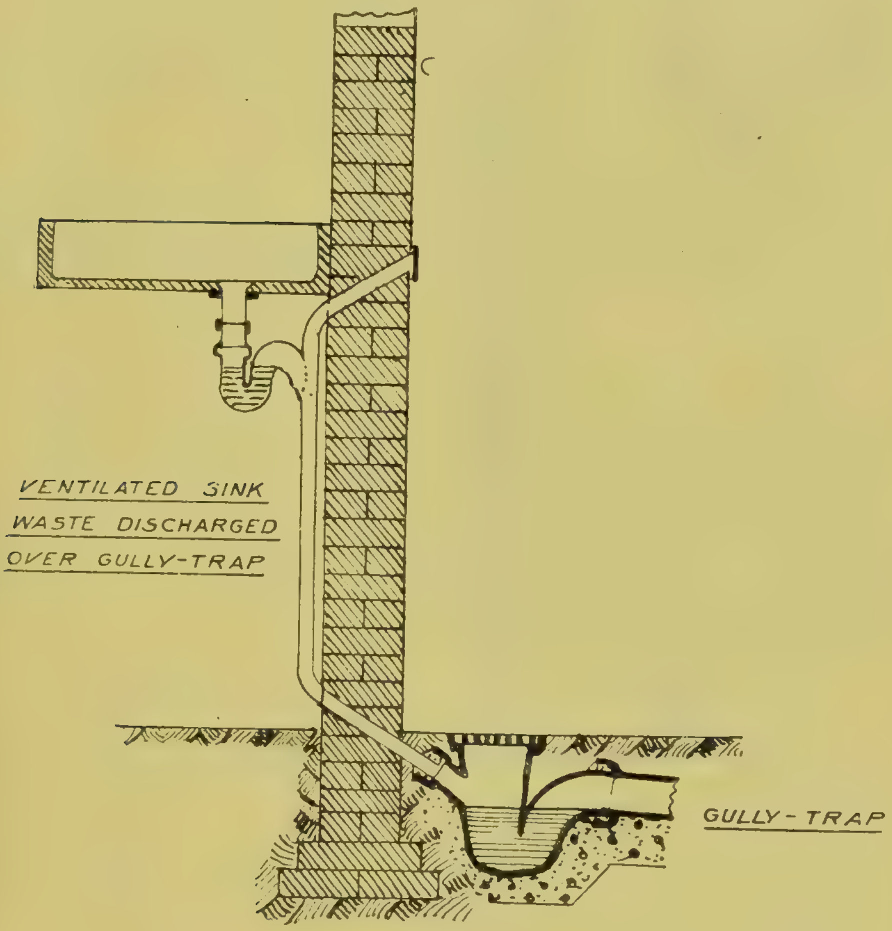
VENTILATED WASTE PIPE FROM RANGE OF LAVATORY BASINS (OR OTHER FITTINGS) SHOWING ANTI-SYPHONAGE PIPE



He shall, as regards the ventilation of the trap of such slop sink or urinal, and the construction of the waste pipe of such slop sink or urinal, comply with all the requirements of the preceding by-laws which are applicable to the ventilation of the trap of a water-closet and the construction of a soil pipe, always provided that the internal diameter of the waste pipe of any such slop sink or urinal shall not be less than 3 inches, and where the internal diameter of such waste pipe is 3 inches the weight of such pipe of every

10 feet of length shall, if such waste pipe be constructed of lead, be not less than 60 lbs. and if such waste pipe be constructed of cast iron, the weight of such pipe of every 6 feet of length shall be not less than 40 lbs.

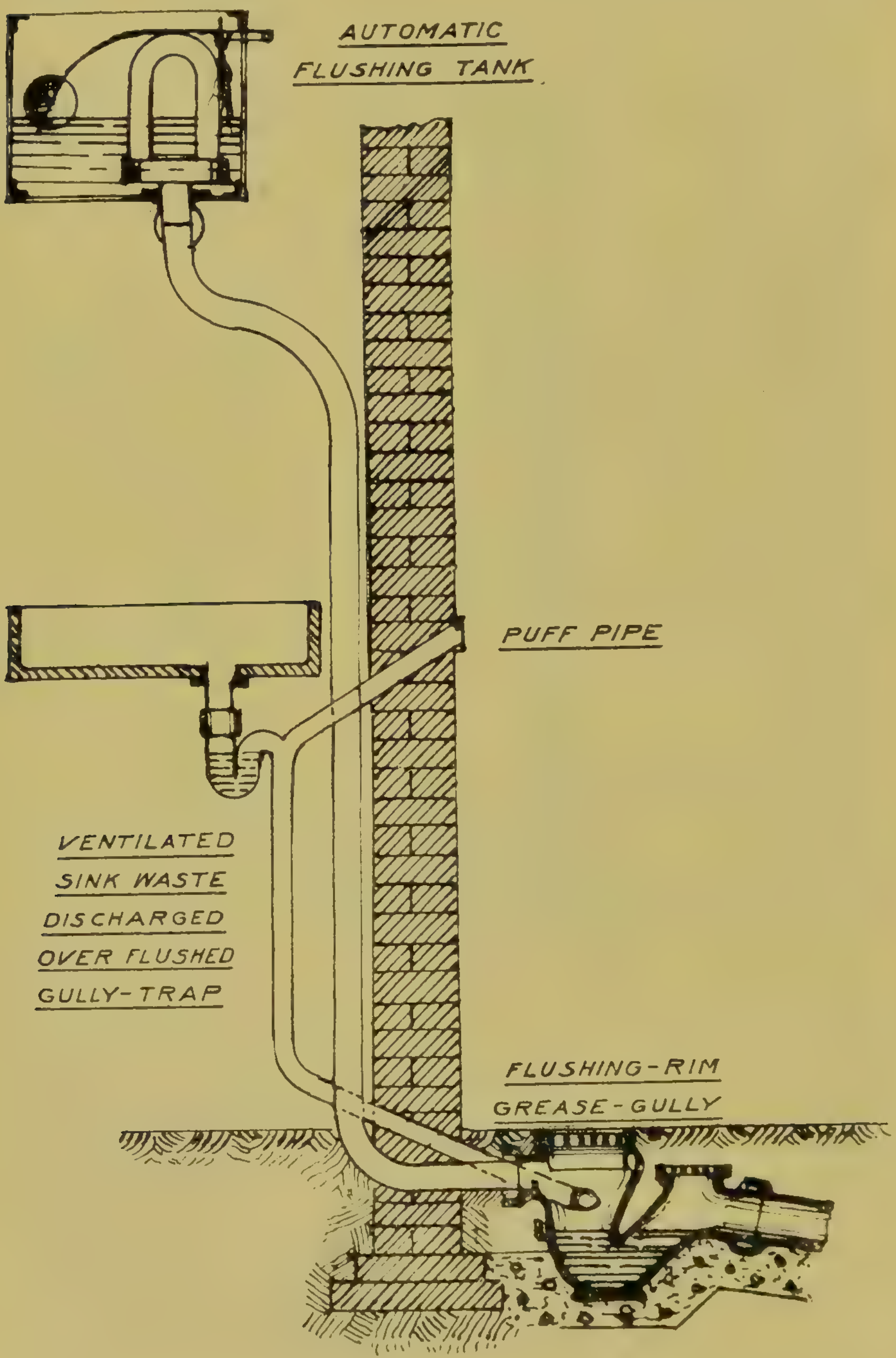
The owner of any building shall, as respects such building, at all times maintain in a proper state of repairs all pipes, drains, and other means of communicating with sewers, and the trap and apparatus connected therewith.



A person who shall newly fit or fix any apparatus in connection with any water-closet existing shall, as regards such apparatus and its connection with any soil pipe or drain, comply with such of the requirements of the foregoing by-laws as would be applicable to the apparatus so fitted or fixed if the water-closet were being newly constructed.

There are special by-laws also in reference to outside closets, basement closets, earth closets, privies and cesspools.

Every person who shall intend to construct any water-closet, earth closet, or privy, or to fit or fix in or in connection with any water-closet, earth closet, or privy any apparatus or any



trap or soil pipe, shall before executing any such works, give notice in writing to the clerk of the Sanitary Authority.

The occupier of any premises shall cause every water-closet belonging to such premises to be thoroughly cleansed from time to time as often as may be necessary for the purpose of keeping such water-closet in a cleanly condition.

Provided that where two or more lodgers in a lodging-house are entitled to the use in common of any water-closet the landlord shall cause such water-closet to be cleansed as aforesaid : one closet to every twelve persons.

The owner of any premises shall maintain in proper condition of repair every water-closet and the proper accessories thereof belonging to such premises.

PENALTIES.

Every person who shall offend against any of the foregoing by-laws shall be liable for every such offence to a penalty of two pounds, and in the case of a continuing offence to a further penalty of forty shillings for each day after written notice of the offence.

BYE-LAWS OF THE BOMBAY MUNICIPALITY.

Construction of Water-Closets and Privies.

(Clause (*a*), Section 461).

5. Every person who shall construct a water-closet for use in connection with a dwelling house shall comply with the following regulations :—

(*a*) He shall cause such water-closet to be separated from any room, intended to be used for human habitation, by a *dead* wall which shall be lined *internally to a height of six feet* with a smooth, impervious, non-absorbent coating of neat Portland cement not less than half an inch in thickness, or of glass, glazed tiles or polished marble.

(*b*) He shall make, in one at least of the walls of such water-closet, a window of not less than 3 square feet superficial area opening upon an external open space.

(*c*) He shall cause the entrance to such water-closet to be through a lobby or *bath-room having at least one window*, or through a gallery which is entirely open to the outer air on one side.

(*d*) He shall not construct any portion of such water-closet so as to be within a distance of 3 feet from the boundary of the owner's premises, provided that this rule shall not operate to prevent a water-closet being constructed to abut on a street or service passage or open space intended to be permanently reserved as such.

6. Every person who shall construct a privy (including in this expression a privy on the intermediate system) shall comply with the following regulations :—

(*a*) He shall provide on each side of such privy, except the entrance side, an open space of at least 3 feet in width within the limits of the owner's premises and open to the sky.

(*b*) He shall cause any entrance gallery or communicating bridge to be at least 3 feet in width and open to the external air on both its sides and to be shut off from any portion of any dwelling-house by a closely fitting door.

(*c*) He shall make, in one at least of the walls of such privy, a window of not less than 3 square feet superficial area, opening upon an external open space.

(*d*) He shall cause the walls of such privy to be lined *internally* with a smooth, impervious, non-absorbent coating of neat Portland cement not less than half an inch in thickness or of glass, glazed tiles or polished marble to a height of not less than five feet of such privy.

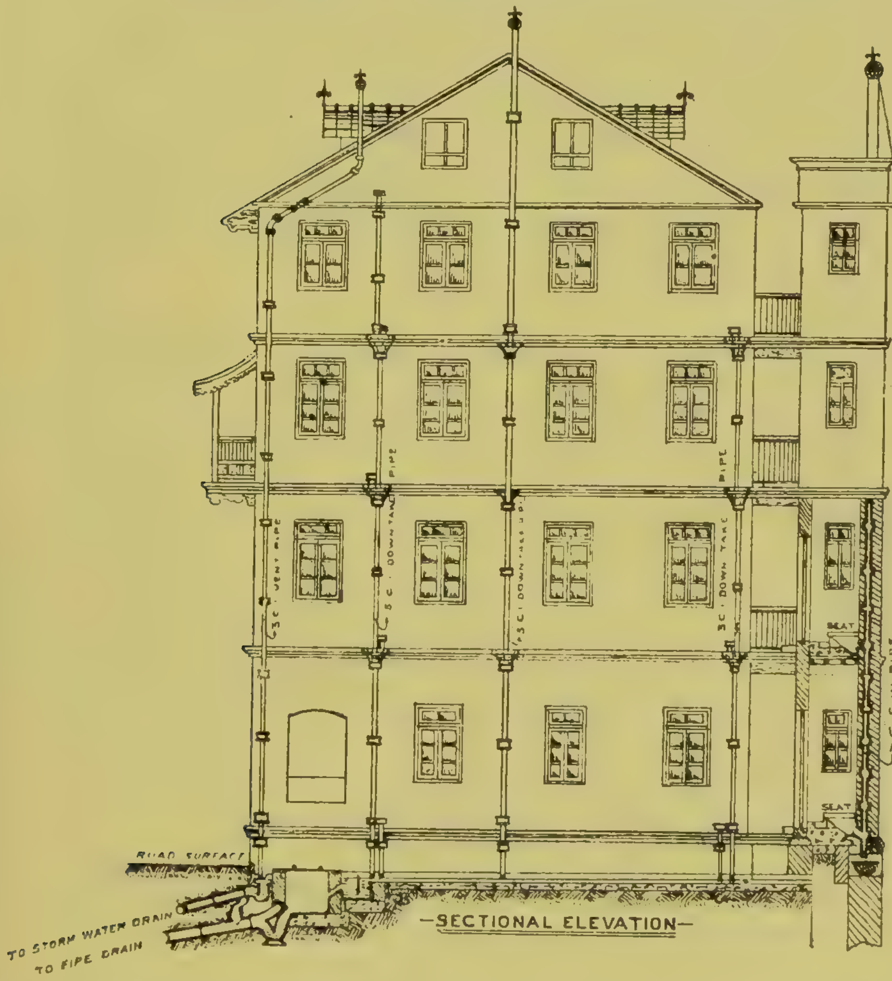
RULES FOR HOUSE AND STABLE DRAINAGE.

Open Drain.

1. In no instance shall a drain interior to a building for the conveyance of the house-sullage to the street-sewer be an open drain.

2. Open drains shall be constructed according to the plans in the office of the Deputy Executive Engineer, Drainage Department. The Drainage Engineer shall have the option of allowing the open drain to be in the centre of a house gully and without side walls. The bottom part or invert shall be lined with a 4″ half round stoneware channel, the remaining part of the drain being plastered with at least

—TYPE OF HOUSE-CONNECTIONS WITH AN OPEN DRAIN—



a 1″ coating of cement and sand (1 to 1) trowelled to a smooth surface or with any other impervious material.

3. At the end of the open drain a silt chamber 2′ long by 7″ wide, and 12″ deeper than the bed of the drain, shall be constructed with a vertical cast-iron grating 1′-6″ from the open drain the full size of the silt chamber. This shall discharge into a gully trap connected to an inspection chamber. (See sketch, p. 213.)

4. The inspection chamber shall be not less than 3′ long by 18″ wide, constructed of brick work laid on cement concrete and be internally plastered with a 1″ coat of cement and sand (1 to 1). In the chamber a stoneware channel with a half round S. W. invert shall be formed of the width and full depth of the pipe drain. The walls shall be brought up to the surface of the ground and covered with a cast-iron air-tight cover and frame.

5. The cover of an inspection chamber shall be of cast iron, air-tight, and fitted with a lip into a grooved frame. The cover and frame of an inspection chamber subject to wheel traffic shall be of cast-iron of heavy pattern. At the connection between the 6″ pipe drain laid in the street by and at the expense of the Municipality and the drain constructed by the owner, an inspection chamber shall be provided fitted with a 6″ stone-ware intercepting sewer trap of approved pattern having a water seal not less than 2″ and a 3 inch ventilating shaft in accordance with Rule 11. In all other respects the inspection chamber shall be constructed in accordance with Rule 4.

6. All down-take pipes shall be of cast-iron, 3″ in diameter and not less than $\frac{1}{3}$″ thick.

7. The connection between every nahani and the down-take pipe shall be by means of a 3″ stoneware or 3″ cast-iron pipe, discharging into a cistern head. Nahani traps may be used, but, if directly connected to the waste water pipes, the latter shall be extended above the roof in accordance with Rule 11.

8. In the case of nahanis abutting on a street or road, the waste water pipes shall discharge into a stoneware gully trap by means of a stoneware or cast-iron bend. The gully trap shall discharge into an inspection chamber fitted with a sewer trap as per Rule 5, or into a private pipe drain. The waste water pipes or nahani connections shall be constructed in accordance with Rule 23 for pipe drains.

9. In the event of the plinth of a house being much higher than the bed of the open drain, nahanis on the ground floor shall discharge into the open drain by means of a 3″ discharge pipe brought down to such a level as to avoid a splash.

10. No water-closet or any arrangement by which night-soil is to be removed on the water carriage system shall, except with the written permission of the Municipal Commissioner, be allowed to be connected with an open drain.

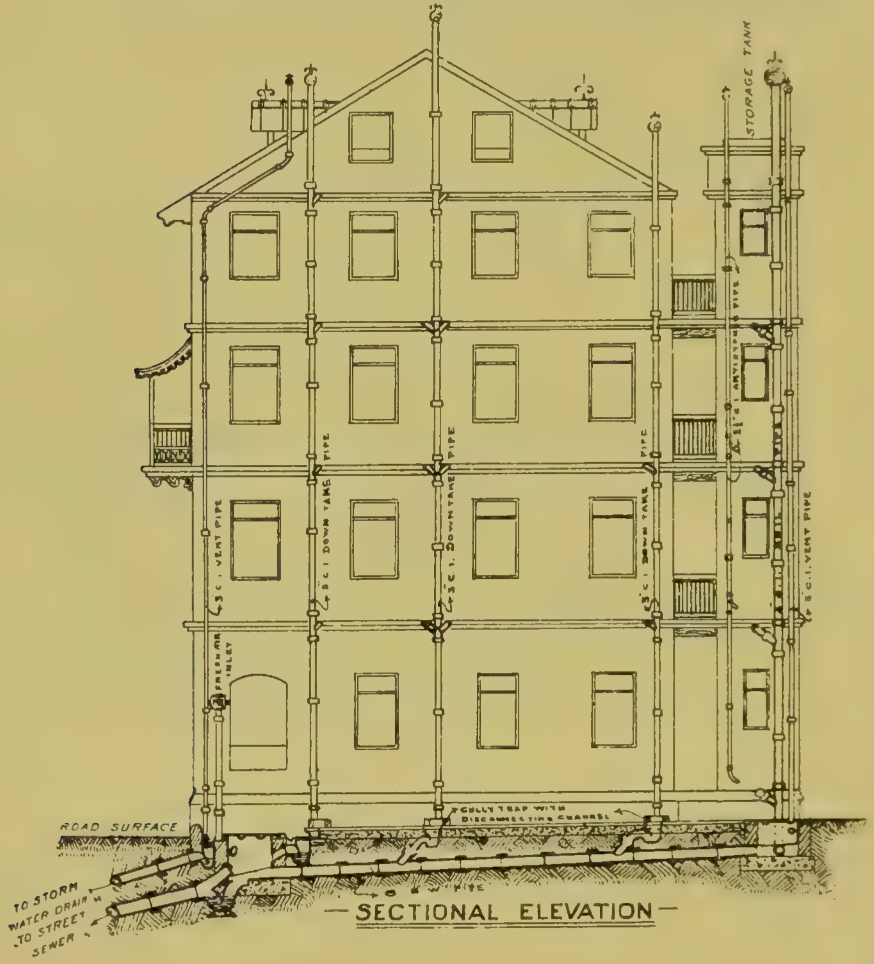
11. Every vent pipe, anti-siphon pipe and waste water pipe shall, if not provided with cistern heads and discharging into an open drain, be protected at the top by a wire dome and shall be (*a*) carried at least 15′ higher than any sky-light or window situated within a distance of 40′ therefrom ; (*b*) carried at least 5′ higher than the eave of the roof if affixed to a wall supporting the eave ; (*c*) erected or affixed so as to create the least practicable nuisance or inconvenience to the inhabitants of the neighbourhood.

12. The surface of all house gullies not occupied by, or beyond what is occupied by, an open drain shall be paved with fine dressed blue-stone or Indian patent stone or other stone approved by the Commissioner. At the lower end of the gully, whether the open drain for sullage or sewage be in the centre or at the side, a jump-weir shall be formed as per full size plan to be seen in the offices of the Drainage Department, so that, while any ordinary flow of sewage will discharge into the connection with the inspection chamber a rush of storm-water will jump over the opening and pass into the storm-water drain. (See sketch, p. 216.)

Pipe Drain.

13. In all cases where house-owners desire to drain their premises by a pipe drain instead of an open drain, the drain shall be a 6″ stoneware pipe drain jointed in cement and laid at a gradient of 1 in 50 where practicable. When necessary a flatter gradient may be allowed by the Drainage Engineer.

—TYPE OF HOUSE CONNECTIONS WITH A 6″ PIPE DRAIN



—SECTIONAL ELEVATION—

14. In such houses as are without gullies, a heavy cast iron pipe drain (the joints to be run with molten lead and soundly caulked) may, in accordance with Section 240 of the Municipal Act, be laid under the building. Pipe drains may be of 4 inches diameter, only when allowed by the Drainage Engineer.

15. At the connection between the 6″ pipe drain laid in the street by and at the expense of the Municipality and the pipe laid by the owner, an inspection chamber shall be constructed and fitted with a 6″ stoneware intercepting sewer trap having a water seal of not less than 2″ and with fresh air inlet, the open end of the pipe being placed wherever practicable above the roof or in such position that, in the event of a reverse current of air, it will not cause nuisance or annoyance to passers-by or persons residing within or near to the premises. (See sketch page 216.)

16. The cover of all inspection chambers shall be of cast-iron, air-tight and fitted with a lip into a grooved frames. The cover and frame of an inspection chamber subject to wheel traffic shall be of cast-iron of heavy pattern. In all other respects the inspection chamber shall be constructed in accordance with Rule 4.

17. Inspection chambers shall be so placed on any pipe drain that no portion thereof more than 75′ long shall be without an inspection chamber. An inspection chamber at the point of every change of direction in any drain shall be deemed indispensable.

18. Every 6″ gully trap shall be connected with a 6″ pipe drain by means of a 4″ stoneware branch pipe.

19. The head of every pipe drain shall be provided with a 3″ cast-iron or galvanized iron vent pipe.

20. A nahani trap, approved by the Commissioner, shall be provided in every nahani except those specially provided for in Rule 23. (See sketch page 216.)

21. All down-take pipes shall be of cast-iron, 3″ in diameter and not less than $\frac{1}{8}$″ thick.

22. Every down-take pipe shall be carried up above the roof as a vent-pipe and be protected at the top by a wire dome as far as practicable, in accordance with the distances specified in Rule 11 as amended.

23. Every nahani on the ground floor shall discharge into a stoneware gully trap by means of a 3″ stoneware pipe, and every down-take or waste water pipe shall be discon-

nected from the gully trap by means of a disconnection channel discharging into the gully trap. (See sketch page 216.)

24. In the event of there being an open *chauk* in the house, the nahanis shall be constructed adjacent to the external wall of the *chauk* to allow of the down-take pipes being fixed to and carried up against external walls.

Water-Closets.

25. In the case of water-closets, native pattern soil pans of design approved by the Drainage Engineer may be provided and shall be properly laid and bedded in cement concrete at the required level and connected by means of porcelain traps and 4″ stoneware pipe and bends with an inspection chamber or soil pipe as the case may be. European pattern soil pans of design approved by the Drainage Engineer may be provided and shall be fixed in position with a teakwood moveable or hinged seat. (See sketch.)

26. The junction between a closet and a branch, if the latter is of lead, shall be effectively made by a brass ferrule soldered with a wiped joint to the lead pipe, and the joint between the porcelain trap and the brass ferrule made in cement, boiled oil and spun yarn, or soldered to porcelain. (See sketch.)

27. All soil pipes shall be 4″ in diameter and of cast-iron to less than 3/16″ in thickness. The connection between the soil pipe and the water-closet trap shall be by means of a pipe fitted with a screw cap external to the wall for cleaning purposes. (See sketch.)

28. Every soil pipe shall discharge into the 6″ stoneware pipe drain by means of a 4″ stoneware bend into a chamber fitted with a cast-iron cover. (See sketch).

29. In every case where there is a tier of water-closets one above another a 2½″ anti-siphon pipe shall be taken from each water trap except that of the highest water-closet and carried up above the roof and to such height as is prescribed in Rule 11. (See sketch.)

30. A three-gallon automatic or pull off flushing cistern of a pattern approved by the Drainage Engineer shall be securely fixed to the wall at least 5 feet above the seat and shall be connected by means of a $1\frac{1}{4}''$ lead pipe with an Indian rubber cone to the connection with the closet. (See sketch.)

31. All such flushing cisterns shall be supplied by means of an efficient water supply from a reservoir tank placed in a suitable position and height. The capacity of this reservoir tank shall not be less than 90 gallons for each seat (See sketch.)

Rules in connection with the construction of privies on the Intermediate Water-Carriage System.

32. Every proposal for the construction of privies on the intermediate water-carriage system shall comply with Clause 6* of the Bye-laws and also with the definition of the privy on the intermediate system at page 5† of the new Building Bye-laws.

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* Every person who shall construct a privy (including in this expression a privy on the intermediate system) shall comply with the following regulations :--

(*a*) He shall provide on each side of such privy, except the entrance side, an open space at least 3 feet in width within the limits of the owner's premises and open to the sky ;

(*b*) He shall cause any entrance gallery or communicating bridge to be at least 3 feet in width and open to the external air on both its sides and to be shut off from any portion of any dwelling-house by a closely fitting door ;

(*c*) He shall make in one at least of the walls of such privy a window of not less than 3 square feet superficial area opening upon an external open space ;

(*d*) He shall cause the walls of such privy to be lined internally with a smooth, impervious, non-absorbent coating of neat Portland cement not less than half an inch in thickness or of glass, glazed tiles or polished marble to a height of not less than five feet above the floor of such privy.

† " Privy on the intermediate system " means a privy the excrementitious matter from which is collected in a suitable receptacle on the ground floor and flushed therefrom with water at regular fixed intervals by means of an automatically discharging tank fixed at a height of not less than 6 feet above the receptacle, and kept continually supplied with water by means of a separate supply tank.

33. Each seat shall be provided with a porcelain or earthenware pan with a sharp slope, or with a midmost flat glass plate with a sharp slope embedded on either side with cement or porcelain tiles. (See sketch page 187.)

34. In case of a privy with a range of seats, arrangement shall be made to leave inspection holes at a distance of at least 5 feet for cleaning purposes. These holes shall be covered with C. I. frames with a hinged lid of the same pattern as hydrant boxes over the water mains. The opening over the gully traps shall also have covers of the same kind and not grating. (See sketch.)

35. The capacity of the flushing tank shall be determined by the length of the drain behind the privy and the number of storeys at the premises in which the privies are situated. The distance from the centre of one privy to the centre of the next shall not be less than 3 feet and for every foot run of the drain, one gallon flush shall be provided and for every storey one gallon more irrespective of the number of privies on each storey. For example, if the length of the drain is 12 feet and there are three upper storeys, the capacity of the tank will be 15 gallons. If the length of the drain is 20 feet and there is only one upper storey with 6 privy seats, the capacity will be 21 gallons. (See sketch.)

36. The length of the drain or 6″ S. W. pipe line shall not exceed 20 feet, but if it exceeds this length, it should be graded from either end of the privy so as to meet near the centre, and flush tanks of the capacity mentioned in Rule 35 should be provided at either end.

37. All flush tanks should be regulated to flush twice in one hour.

38. The storage tank should have 20 (twenty) times the capacity of all the flushing tanks combined.

General Rules for the laying of Drains, erection of all cast-iron pipes and their fittings and for testing the same.

39. The pipes must be of well-burnt glazed stoneware, uniform in thickness.

40. No pipe drain shall be less than 6″ in internal diameter, unless otherwise allowed by the Drainage Engineer, and must be laid at a gradient of 1 in 50 wherever practicable, unless otherwise allowed by the Drainage Engineer. Branch drains may be 4″ in diameter.

41. The stoneware pipes shall be all laid and fitted dry previous to the jointing being commenced, such pipes being neatly cut as may need to be shortened in order to bring in the junctions in the exact position required. All the pipes shall be laid perfectly true both in line and gradient and they shall be laid on a 6″ concrete bed in the case of 'made ground,' or when in the opinion of the Drainage Engineer this course is necessary.

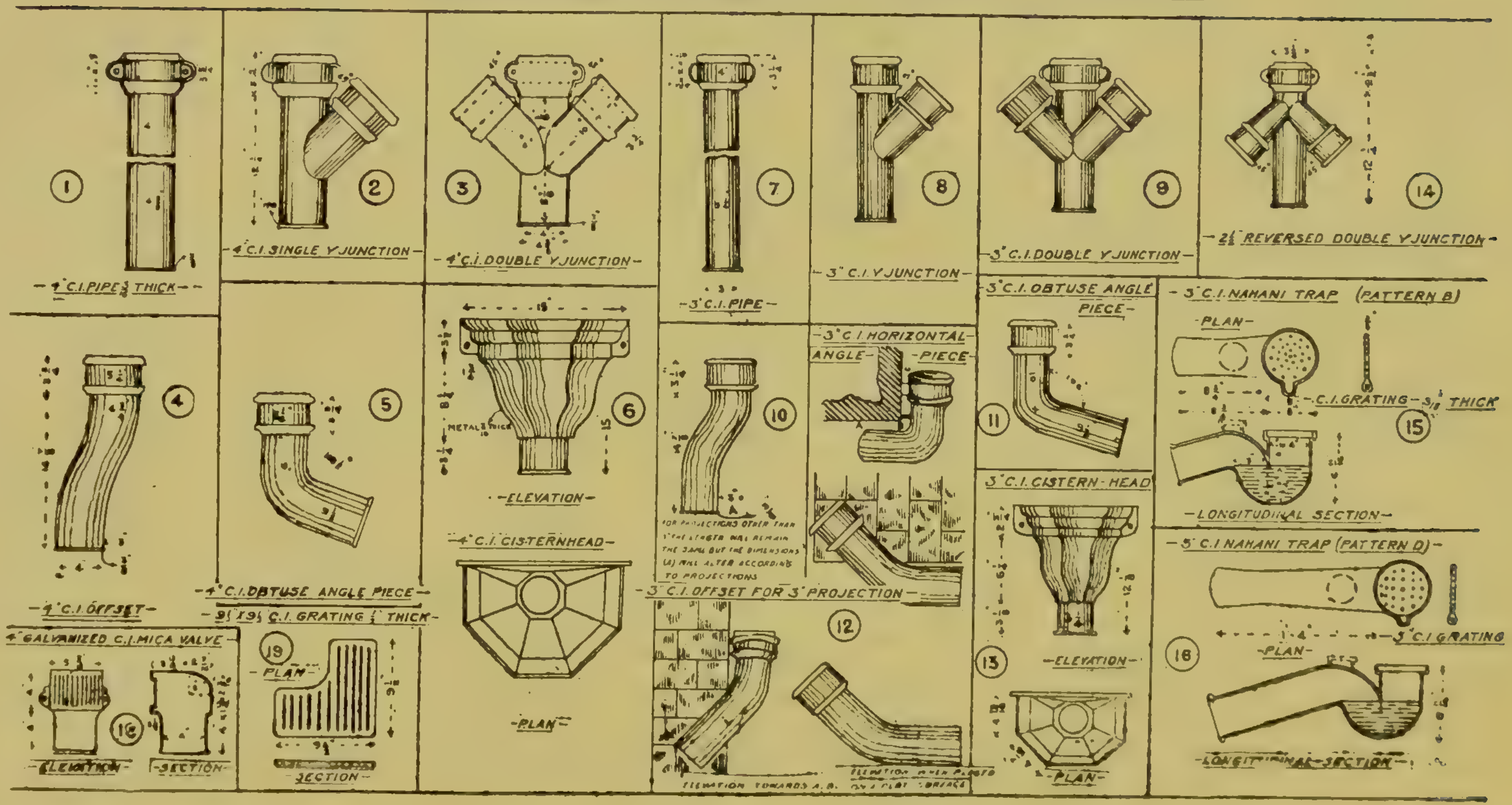
42. All the pipe joints shall be caulked with cemented or tarred gasket in one length for each joint and sufficiently long to entirely surround the spigot end of the pipe, the gasket to be driven as far as possible into the joint by means of a suitable instrument. After the pipes are thoroughly cleaned and moistened, neat Portland cement is to be forced into the joint until the whole space around the spigot, between it and the socket, is quite full, and a splayed fillet of neat cement is to be laid all round the joint.

43. Before filling in the trench the joint of the pipe drains must be proved water-tight by filling the pipes with water to the level of 6″ above the top of the highest pipe in the stretch and heading the water up for the period of one hour or such further time as directed.

44. No stretch of pipe line shall under any circumstances be covered up until inspected and passed by the Head Plumber or the Drainage Inspector of the District as the case may be.

45. The inspection chambers on the pipe drains shall be constructed of brick work laid on cement concrete and be internally plastered with a 1″ coat of cement and sand (1 to 1). In the chamber a stoneware channel with a half round invert shall be formed of the width and full depth of the pipe drain. The walls shall be brought up to the surface of the ground and covered with a cast-iron air-tight

—DIMENSIONED SKETCHES OF THE PIPES FITTINGS &c.—



1
—4" C.I. PIPE 3/8 THICK—
2
—4" C.I. SINGLE Y JUNCTION—
3
—4" C.I. DOUBLE Y JUNCTION—
7
—3" C.I. PIPE—
8
—3" C.I. Y JUNCTION—
9
—3" C.I. DOUBLE Y JUNCTION—
14
—2½" REVERSED DOUBLE Y JUNCTION—
4
—4" C.I. OFFSET—
5
—4" C.I. OBTUSE ANGLE PIECE—
6
—ELEVATION—
METAL 3/16 THICK
—4" C.I. CISTERNHEAD—
—PLAN—
10
FOR PROJECTIONS OTHER THAN 3" THE LENGTH WILL REMAIN THE SAME BUT THE DIMENSIONS (A) WILL ALTER ACCORDING TO PROJECTIONS
—3" C.I. OFFSET FOR 3" PROJECTION—
—3" C.I. HORIZONTAL ANGLE PIECE—
12
ELEVATION TOWARDS A.B.
ELEVATION WHEN PLACED ON A FLAT SURFACE
11
—3" C.I. OBTUSE ANGLE PIECE—
3" C.I. CISTERN-HEAD
13
—ELEVATION—
—PLAN—
—3" C.I. NAHANI TRAP (PATTERN B)
—PLAN—
—C.I. GRATING—3/16 THICK
15
—LONGITUDINAL SECTION—
—5" C.I. NAHANI TRAP (PATTERN D)—
—5" C.I. GRATING
—PLAN—
16
—LONGITUDINAL SECTION—
—9½" × 9½" C.I. GRATING ½" THICK—
19
—PLAN—
—SECTION—
4" GALVANIZED C.I. MICA VALVE
18
—ELEVATION—
—SECTION—

cover and frame. The cover of an inspection chamber shall be of cast-iron, air-tight and fitted with a lip into a grooved frame. The cover and frame of an inspection chamber subject to wheel traffic shall be of cast-iron of heavy pattern.

Soil Waste and Vent Pipes.

46. The socket joints between metal and metal when above ground shall be made completely air-tight with a mixture composed of Portland cement, boiled oil and chopped hemp, and by a ring of hemp gasket.

47. The joints of pipes and shafts above ground after they are thoroughly set must be proved air-tight by smoke produced and applied as directed.

48. All the cast-iron appliances and fittings must be of approved pattern and coated by dipping in Dr. Angus Smith's solution before being used in the work.

49. In case of new buildings the drainage must be in accordance with the plan which has previously been approved by the Municipal Commissioner.

Horse Stables—Public or Private.

50. The foundation of each stall shall consist of at least 6″ of lime concrete well rammed and laid at a slope equal to 1 in 36.

51. Above the concrete shall be put down a layer of good and well selected *muram* properly rammed and finished off to the same slope as the concrete or such suitable paving as may be approved by the Drainage Engineer.

52. Meeting the *muram* or paving and at right angles to the stalls shall be constructed a half round channel 12″ wide of suitably dressed blue stone or other suitable material. (See sketch.)

53. The channel shall have a longitudinal slope of at least 1 in 100 to one point, or more as may be selected, and at each of such points a 6″ by 6″ stoneware gully trap fitted with horizontal and vertical cast-iron gratings shall be fixed. (See sketch.)

54. All the gully traps shall be connected by a 6″ stoneware pipe drain or drains with an inspection chamber constructed on a line of 6″ stoneware pipe drain connected with the street sewer. (See sketch.)

55. The construction of an inspection chamber, the laying of the pipe drain and connecting with the street sewer shall be in accordance with the rules laid down for pipe drains.

56. It shall be incumbent on every owner of a stable to renew the *muram* in the stalls at least twice a year or as often as may be required by a responsible officer of the Municipality.

Cattle Stables.

57. The floor of every cattle stable shall be paved over the whole area with suitably dressed bluestone or other suitable material laid on a 6″ bed of good lime concrete. The paving shall be sloped at an inclination of at least 1 in 60 towards the channel hereinafter described.

58. Behind every range of stalls a half round channel 12″ wide shall be formed with a slope of at least 1 in 60 in every part down to a gully trap hereinafter described. (See sketch.)

59. The channel shall discharge into a catchpit through a glazed S. W. gully trap. The catchpit shall be 3′ by 4′ by 5′ deep. It shall be covered with a strong cast-iron cover fitted into a rebated frame. The catchpit shall be placed immediately at the point of discharge, or lowest point of the channel, and connected with the pipe drain within the premises by means of an inspection chamber built complete with a 6″ intercepting sewer trap. (See sketch.)

60. A horizontal and a vertical iron grating with bars not more than ½″ apart shall be fixed in the catchpit. (See sketch.)

61. The laying of the pipe drain, the construction of the inspection chamber and the connection with the street sewer shall be subject to the rules for pipe drains.

Cesspools.

Drainage of premises not within 100 *feet of a Municipal drain or some place legally set apart for the discharge of drainage.*

62. As far as practicable, buildings of this description shall be drained by open drains in accordance with the rules laid down for such drains.

63. If practicable, the sullage from all nahanis shall be discharged among vegetation or used for gardening purposes but if this is impossible, then the sullage shall discharge into a cesspool having a capacity of at least 50 c. ft.

64. The capacity of a cesspool shall be calculated below the bottom of the inlet drain.

65. The house-drain, if open, shall be connected with and shall discharge by means of a 6″ by 6″ stoneware gully trap into the cesspool. All cesspools shall be closely covered and fitted with a cast-iron air-tight frame and cover.

66. Every cesspool shall be ventilated by a cast-iron or galvanized iron pipe not less than 3″ in diameter.

67. The vent pipe shall be protected at the top by a wire dome and shall be (*a*) carried at least 15′ higher than any sky-light or window situated within a distance of 40′ therefrom ; (*b*) carried at least 5′ higher than the eave of the roof, if affixed to a wall supporting the eave ; and (*c*) erected or affixed so as to create the least practicable nuisance or inconvenience to the inhabitants of the neighbourhood.

68. There shall be a cesspool for the privies separate from that for the nahanis (if any) and it shall have a capacity of at least 3 c. ft. per every privy seat or slot, with a minimum of 25 c. ft.

69. Every cesspool must be placed in a position convenient for the access of Municipal carts.

70. Every cesspool shall be constructed of brickwork in cement laid on cement concrete and internally plastered

with a 1″ coat of cement and sand (1 to 1). The walls shall be brought up to 6″ above the surface of the ground, and the cover mentioned in Rule 3 shall be placed upon them.

71. An arrangement must be made with the Municipal $\frac{\text{Head Plumber}}{\text{Inspector of Drains}}$ to attend at the premises to see the execution of the drainage work and the making of any connection that may be necessary with the Municipal drain.

72. No connection must be made with a Municipal drain nor must the same be exposed except in the presence of the $\frac{\text{Head Plumber}}{\text{Inspector.}}$

73. The whole of the work must be done under the supervision of the Municipal $\frac{\text{Head Plumber}}{\text{Inspector.}}$

74. The said $\frac{\text{Head Plumber}}{\text{Inspector}}$ will see that the principles adopted by the Municipality are carried out, but no such close supervision can be given by any Municipal Officer as to relieve the house owner and his plumber from the duty of taking due care in the execution of the work and providing good and sufficient materials and workmanship.

Inspection of Water-Closets.

On examination of the fittings and drains it will be seen whether the laws and bye-laws have been properly carried out.

Taking first a house on the modern system of water-closet drainage, a wash-down basin has been fitted against the outer wall discharging into a 4-inch lead soil pipe, which is connected to a cast iron soil pipe outside the wall, carried up 5 feet above the highest adjoining window.

An anti-syphon pipe has been placed on the arm leading to the soil pipe about 6 inches from the trap of the water-closet and carried above the highest window. The connection between basin and soil pipe should be a brass socket ferrule, into which cement is placed, fixed to the lead branch of the soil pipe by means of a wiped solder point.

The trap is self-cleaning with not less than 2½ inches seal of water.

The connection between the lead arm of the soil pipe and the iron soil pipe outside the house should be a brass ferrule soldered, and lead run into the joint.

The soil pipe discharges directly into a 4 to 6-inch earthen pipe, preferably a 4-inch with a fall of 1 in 40, laid on cement.

There is an inspection chamber lined with white, glazed bricks, the floor of cement and the channels curved, a trap at the sewer end, on a raking arm with fixed stopper in position.

The waste pipes from bath and slop sink should, after discharging on to a gully trap, discharge into the inspection chamber to assist in flushing.

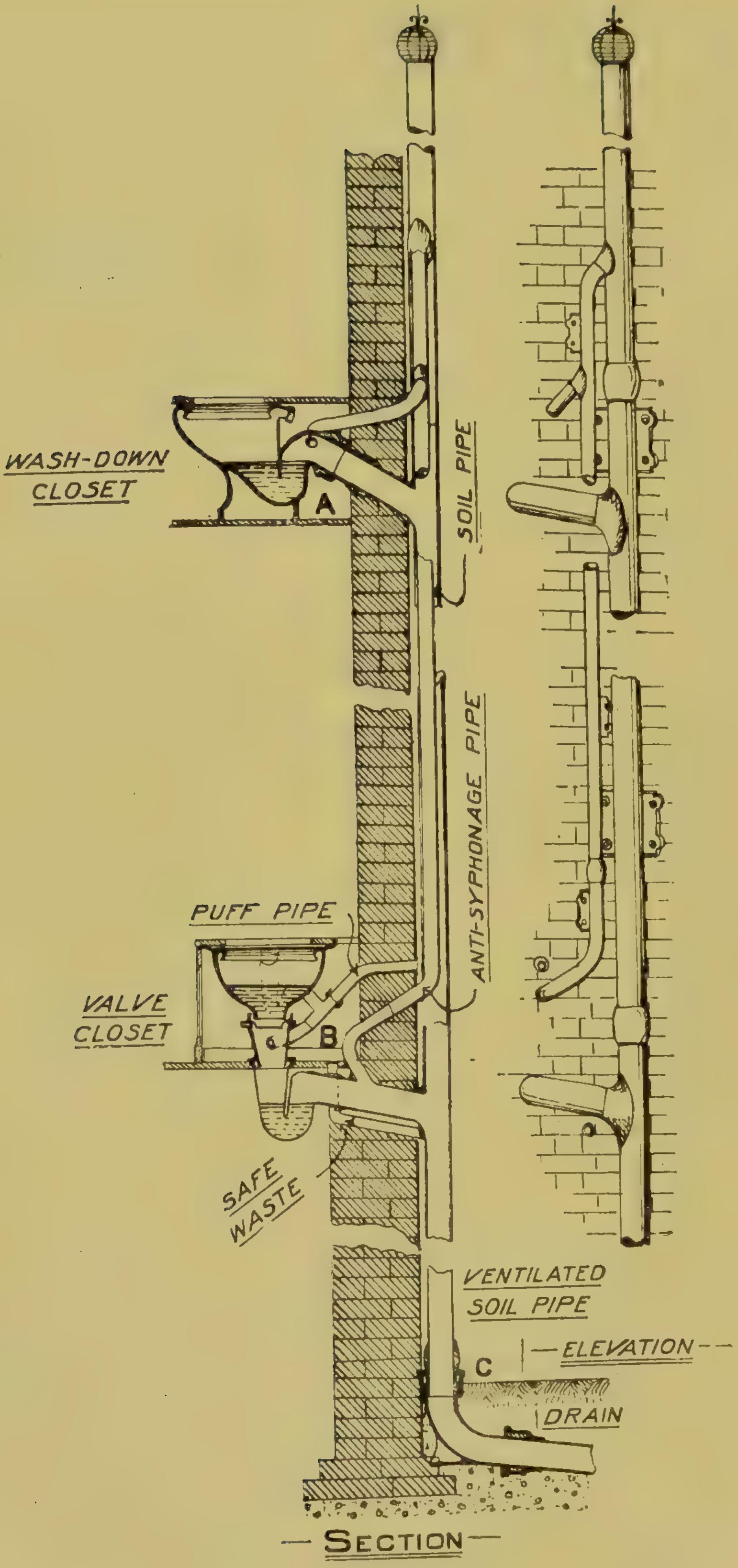
An inlet pipe with a mica flap valve, fitted so as to allow the ingress of air, should be fixed to the inspection chamber.

The flushing cistern, distinct from the supply tank, should be examined. The contents of the water-closet basin, with the 3 gallon flush every time the water-closet is used, pass into the house drain through the inspection chamber, and thus to the sewer.

Inspection of Drains.

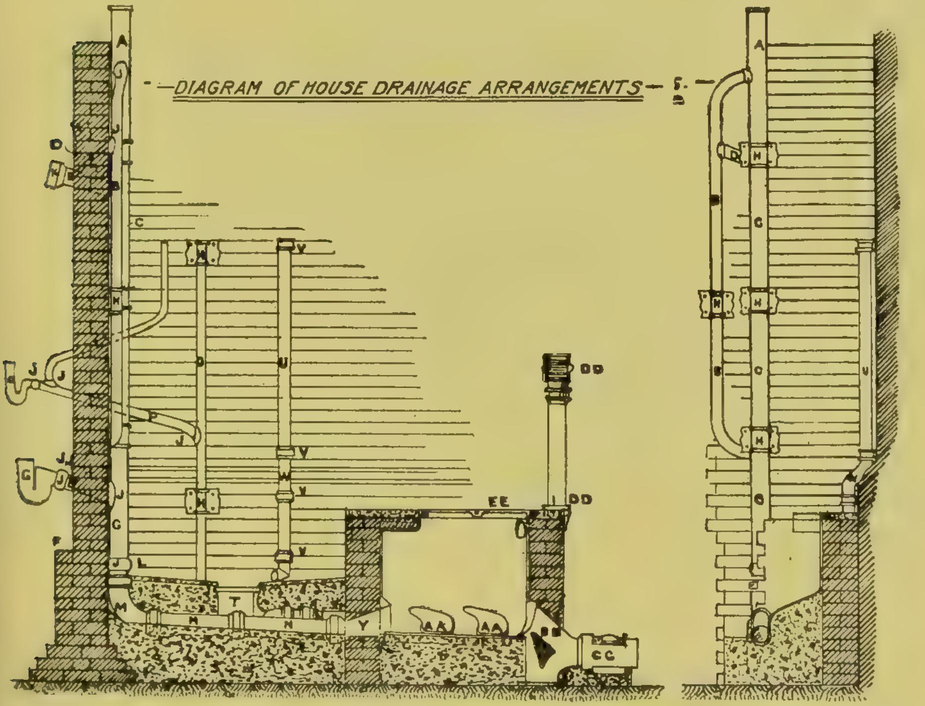
"*Drain*" means any drain of and used for the drainage of one building only or premises within the same curtilage and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

Drains must be inspected as to their bed, their fall, their jointing and construction. Note whether they pass


WASH-DOWN CLOSET
A
SOIL PIPE
ANTI-SYPHONAGE PIPE
PUFF PIPE
VALVE CLOSET
B
SAFE WASTE
VENTILATED SOIL PIPE
C
ELEVATION
DRAIN
SECTION

round or under the house. If under, find of what material they are made, whether of iron as they should be or of earthenware; if of latter, they must be bedded in cement. It must be discovered whether or not a disconnecting trap provided with a fresh air inlet exists between the house and the sewer.

The drains must be tested, the smoke or hydraulic test being applied. If the *smoke test* is to be applied, the Eclipse Smoke Generator or one or other of the smoke testing machines is emlpoyed.



—SECTIONAL ELEVATION— —CROSS SECTION—

The *Eclipse Smoke Generator* is most widely used and consists of three parts, a double action bellows opening into a cylinder of copper, in which the substance from which the smoke is to be generated is placed, and an out-let tube which is passed into the drain. The cylinder is placed in a tank of copper and is provided with a cover of the same metal which completely envelopes the cylinder when inverted over it. When the machine is to be used, the cover is removed, the tank surrounding the cylinder is filled with water, and the substance from which the smoke is to be obtained—either oily waste or some form of touch paper specially prepared so that it shall smoulder and in smouldering give off smoke in large quantities—is set alight and laid in the cylinder. The cover is then replaced and dipping into the water in the tank forms an air-tight joint and prevents the escape of smoke. The out-let tube is then placed in the drain, an entrance having been found for it at some inspection eye in connection with a trap, or elsewhere along the course of the drain. By pumping air from the bellows into the cylinder, the oily waste, etc., is set smouldering. The smoke generated is driven through the out-let pipe into the parts of the drainage system which are to be tested.

When the pumping has filled the cylinder full of smoke, the connection between the cylinder and pumping bellows may be shut off. As soon as smoke is seen to issue from the top of the soil pipe or other natural out-let, further escape from these is prevented by plugging them with clay or damp cloth, and the pumping is resumed. When it is concluded that a sufficient quantity of smoke has been driven into the drains, etc., pumping is stopped. This time if there is no escape of smoke from the drains, etc., the cover of the cylinder will remain stationary and show no signs of sinking. If, however, there be any flaw in the system, the cover sinks, and a search must be made till the point where smoke is escaping is found.

In the *Hydraulic test* the drains are subjected to the pressure of a head of water, the system being examined in sections. The first section may extend from the first water closet to the first inspection eye, which may or may not be the point where the drain is disconnected from the sewer. At this point the drain is plugged by means of a rubber bag inflated with air or by means of a special apparatus like Addison's Patent Drain Stopper. The system is then filled with water from the first water closet and when full the level of the water in the basin of the water-closet is noted. At the end of one or two hours the level of the water is again taken, and if it has not varied the system is sound. If the water has subsided, the point where leakage has occurred must be sought for. The remaining sections are tested in the same way, the plug being inserted just beyond the last section tested.

For old drains this is a very severe test. Moreover, since the water pressure is greatest at the lowest point, the strain also will be greatest at this point. In applying this test to waste water pipes, the pipe will be plugged at the lower end and the water turned on at a sink tap till the pipe is full and a constant level of water obtained in the sink. The further procedure is as described above. Generally speaking, for every additional foot of water in the pipe being tested there results a ½ lb. of pressure to the square inch.

AMOUNT OF WATER REQUIRED FOR WATER-CLOSETS AND THE METHOD OF SUPPLY.

The amount of water supplied to large towns varies with the facilities of supply and the demand.

In an ordinary residential town in England 30 gallons per head per day, including water for water-closets, is considered sufficient and is distributed thus :—

	Gallons.
Cooking	·7
Drinking	·3
Ablution	5·0
House-Cleaning	3·0
Laundry	3·0
Baths	4·0
Water-Closet	6·0
Waste	3·0
	25

To this should be added 5 gallons per head for Municipal purposes—flushing of drains and road watering and fire and, if a manufacturing town, another 5 gallons per head per day, making in all 35 gallons per head per day.

In large manufacturing centres with railway and docks, another 5 gallons should be added.

In India, owing to the habits and customs of the native, an extra item in the allowance for waste is made, as he cannot resist letting the tap run all the time he is washing himself or his clothes, and there is besides the underground waste due to defective fittings and pipes. So that in a large city in India—Bombay and Calcutta—a supply of 50 gallons per head should be estimated for, but in other towns and cities a supply of 30 to 40 gallons is ample.

When the pressure of water in the main is not constant and varies in different parts of the city, it is necessary in the case of dwellings over 50 feet high to resort to artificial means of raising the water. This can be done by hand-pump, gas-engine and electric power. All these methods are in use in every city and in Bombay they can be seen at work both in European houses, flats and hotels and in the native *Bazar*. The town supply is delivered into tanks placed at the ground level or below it and the water forced up to a cistern on the roof.

That this practice is accepted by the public can readily be verified by an inspection of the City and the arguments put forward by opponents of the water-closet system are immediately dispelled. In a large and crowded part of the native *Bazar* in Bombay City, there is a high building of 5 storeys occupied by Hindus (Banias) as shops and dwelling rooms. The sanitary arrangements are on the water-closet system and the water is supplied by means of an electric pump. This pump is so placed that, when the tanks on the ground level are full, the water automatically brings into play the electric switch and shuts off the water and the pumps are set going to force the water to the top of the house to cisterns, which supply the cisterns of water-closets on the various floors. Everything works well. There is no nuisance from defective privies and the surrounding passage, paved and tiled, is perfectly clean.

SEWERS.

"Sewer" includes sewers and drains of every description, except the word "drain" interpreted as aforesaid and except drains vested in, or under the control of any authority having the management of roads, and not being a local sanitary authority.

The sewage is carried by means of sewers to the place of disposal by gravitation or pumping.

A sewerage system may be combined or separate.

The "combined system" is that by which all rain and storm water, as well as sewage, is carried away by one set of sewers.

In the "separate system" there is provided a separate system of drains and sewers for rain water and sewage, the sewer only receiving that part of the rain which falls on open spaces between houses and open drains which overflow into the sewer.

In India the "combined system" cannot be generally adopted because of the heavy rainfall, which is confined to a few months in the year.

The sewers would have to be made too large for the normal dry weather flow, and become defective and not self-cleansing in the dry weather season.

As it is, sewers may become surcharged in times of continuous rain of 6 to 10 inches in 24 hours, as frequently occurs in India.

Designing and Construction of Sewers.

The designing and construction of sewers is engineering work, but a knowledge of how such work should be done is valuable to a Sanitary student as, in supervising the designing and construction, great care must be exercised in making the sewers water-tight, not only to prevent the sewage leaking out, but also to prevent the sub-soil water entering into the sewers and thus increasing the amount of sewage to be dealt with at the outfall. In many places the quantity of sub-soil water is enormous especially in light, sandy soils where the sewers are laid with difficulty, owing to the height of the sub-soil water and the joints becoming defective due to subsidence of the sewer. The amount of rainfall admitted into sewers has to be considered.

Before covering in a new sewer, all pipes should be carefully tested by filling them with water, so that leaky joints may be avoided.

Ventilation of Sewers.

There are many agents at work affecting the ventilation of sewers :—The rate of decomposition of the sewage, temperature, pressure, wind, volume of the sewage, gradient and discharge of steam into the sewers.

The principle of ventilation is, by equalising the pressure inside and outside the sewer, to cause a free current of fresh air to pass in and the foul air to pass out at the highest point well above the windows of the highest houses.

Sewers may be ventilated by open grids at the street level, well away from dwellings, by vent shafts attached to houses, or by building separate shafts at suitable points every 300 feet along the length of the sewer, every joint being made air-tight.

Open grids on the ground level are objectionable, and should be avoided if possible.

In tropical countries the temperature of the air in the sewer is lower than the atmospheric air outside, while in England the reverse is the case. In Bombay, the mean temperature of the sewer air is 76° Fah. while the temperature outside is 79·5° Fah. At Cawnpore the temperature of the sewer air is 83°.

The rate of decomposition of sewage varies with the pressure and temperature, and the gases of decomposition are therefore much more freely given off in tropical climates. The chief gases found in sewers, which are dangerous to life, are :—

carbon dioxide, CO_2 ; marsh gas, CH_4 ; nitrogen, N.; ammonia, NH_3 ; sulphuretted hydrogen, H_2 S. and carburetted hydrogen, $C_2 H_4$; and great care should be excercised, when examining sewers for cleansing purposes, to see that these gases are not present in any quantity.

Various methods have been adopted to purify the air of sewers : Charcoal trays, permanganate of potash (Reeves' process), gas lamps in the ventilating shafts, or street lamps used as vent shafts, fans and ejectors.

There is no hard and fast rule regarding the method of ventilating sewers ; much depends on the climate, the form and position of the sewer.

Messrs. Shone and Ault claim that efficient ventilation of drains and sewers, like the efficient ventilation of mines, can be secured only by abandoning the so-called natural system and substituting therefor adequately controlled and regulated mechanical means.

Modifications of the Water Carriage System.

In addition to gravitation and pumping, many modifications have, from time to time, been advocated, and are now in use, and it is necessary to shortly mention them here.

The Lieurner System.

This is a pneumatic system and consists of collecting the night-soil and slop water only, direct from the water-closet through hermetically closed iron pipes, into chambers, by creating a partial vacuum in the chambers ; the contents of the water-closet pass into an iron syphon tank, hermetically closed. From this tank the sewage is drawn, by the vacuum created by the pumping station, through iron pipes into the street sewer, and thence into iron chambers of the district reservoir, which is placed underground, in the centre of a district of about 30,000 people.

By a series of valves, these district reservoirs receive the contents of the street sewers, which ultimately pass into the central reservoir at the pumping station.

The advantages claimed are, that the sewers and house drains are air-tight and there can be no leakage and no foul air that the pipes and sewers can be laid irrespective of gradient and no water is required, and that the whole process takes only a few minutes and can be repeated as often as necessary.

The sewage thus received at the central reservoir is manufactured into poudrette and sold as manure.

The system is at work in Trouville, Amsterdam, South Africa, and Stanstead, England, and is found to be satisfactory.

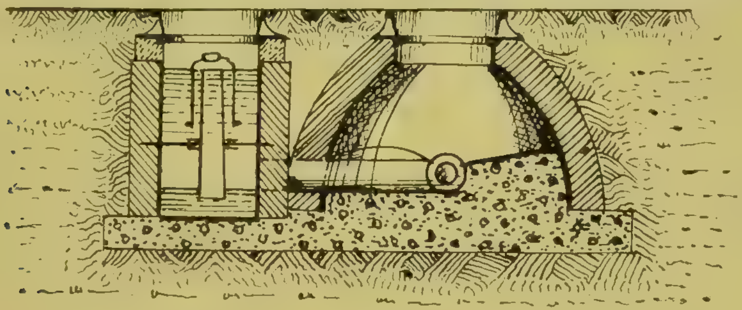
Each house connected has the ordinary sanitary fittings, water-closets, &c. No special fittings of any kind are required in the house. The sewage, however, instead of passing directly into the drain and thence into the sewer, as in the English system, is collected in an underground receptacle, a small iron tank, fitted with a syphon trap to cut off foul air from the premises and to prevent the admission of any foreign bodies, such as brushes or mops, which might tend to block the sewers. Each of these receptacles is ventilated by means of the soil pipe or a special ventilating shaft, and communicates by means of an iron pipe, about 4 inches in diameter, with the street sewer. On each of the house drains there is a valve which can be used for disconnecting the house from the sewer if ever the necessity arise. The street sewers pass directly to the receiving reservoir of the section. The mode of working is as follows: For six or twelve hours the sewage is allowed to collect in the house receptacles. A man then visits each district in succession, and by opening certain valves places all the street sewers, with their connected houses, in direct communication with the district receiver, which is kept exhausted of air. Immediately the valves are opened, the air pressure outside forces the contents of all the house receptacles into the sewers and into the collecting reservoir. This is effected in a very few seconds. When all the street sewers are thus emptied the valves are again closed, cutting them off from the receiver. The receiver is next placed in connection with the main sewer when the whole of the contents is with extra-ordinary rapidity discharged therein and passes directly to a large tank at the sewage works. The district sewers are about 6 inches in diameter, and the main sewer is 8 inches to 12 inches in diameter. Of course, all are of iron, with perfectly air-tight joints.

METHODS OF REMOVAL OF SEWAGE IN SEWERS.

It must be thoroughly understood that the water carriage system, however valuable it is for large cities in India, with an adequate water supply and proper facilities for the disposal of sewage, cannot be adopted in other places where the water supply is deficient.

—DETAILS OF FLUSHING TANK—

—WITH AUTOMATIC ANNULAR SYPHON—



—SECTION ON LINE A. B.—

The cities of Bombay, Calcutta and Madras are partly sewered. Although in Bombay most of the excreta is discharged into the sewer, either by water-closets, or by pail depôts, there are still many areas undrained. The water-closet system is not universal throughout these cities. There are no other towns in India, besides these three mentioned, where the water supply is sufficient for a proper system of sewerage and water-closet system to the houses ; Cawnpore and Delhi, Ahmedabad, Poona, Lucknow, Agra and others are however progressing in this direction.

Under these circumstances, before advocating a sewage system it will be necessary to enquire about :—

The population ; the amount of water available per day per head of the population ; the cost of the system and the connection of houses; the class of people who will use the water-closet; the geographical conformation of the area to be drained; the place and manner of disposal of the sewage, and the degree of purification required; the rainfall.

A sewer must be self-cleansing to be efficient; self-cleansing means that the water supply per head of the population is sufficient to carry off the sewage and silt, at the rate of 3 feet per second in hot climates; in order that this result may be achieved, the fall or gradient must be sufficient, or an artificial method of pumping must be adopted.

In most of the large towns of India, some system of drainage has been adopted for the urine and sullage water, while the night-soil is removed by hand or carts either to hopper depôts or trenching ground.

Sewers are made of glazed earthenware or iron pipes up to 18 inches and 2 feet, and in these sizes circular; when of larger dimensions, they may be of brick or cement and of an ovoid shape.

In laying a separate system, smaller sewers and man-holes may be laid with a great reduction of expense. A man-hole should be placed at every change of direction or where two sewers meet, and on straight lengths of sewer at every 100 yards.

The size of the sewers will depend on the amount of sewage and can be ascertained by the population and the water supply per head. In rural districts the amount of water supply may be taken to be 10 to 25 gallons per head per day in large urban and manufacturing districts, 20 to 40 or more. A town of 30,000 people, without any important factories and having a water supply of 20 gallons per head, will have to dispose of 600,000 gallons of sewage per day; and in addition a certain amount of rain: in English cities provision is made for 1 to 2 inches per day, half of this passing off in six hours.

In India, where the rainfall is sometimes from 6 to 10 inches within 24 hours, a certain amount will find its way into the sewers, even if a separate system is provided for storm water.

The Local Government Board, England, allows storm-water, exceeding six times the normal dry weather flow of sewage, to be passed into a water course, which means that all sewage disposal works should be expected to treat up to six times the normal flow of sewage.

The sewer then should be capable of conveying half the average daily flow in six hours, or in the case of a town of 30,000 people, with a water supply of 20 gallons per head, 300,000 gallons in 6 hours = 50,000 gallons per hour and 834 gallons per minute.

The sewers should be laid in straight lines, from manhole to manhole, and have even gradients sufficient to insure self-cleansing velocities.

In English sewers, when the sewers are running three-fourths full, the velocity may be as low as 2 feet per second, in the main sewer not less than 2½ feet per second, and in all the contributing smaller sewers not less than 3 feet.

In India the sewage should be carried at a higher velocity not less than 3 feet per second, in order to remove silt and convey the sewage away quickly.

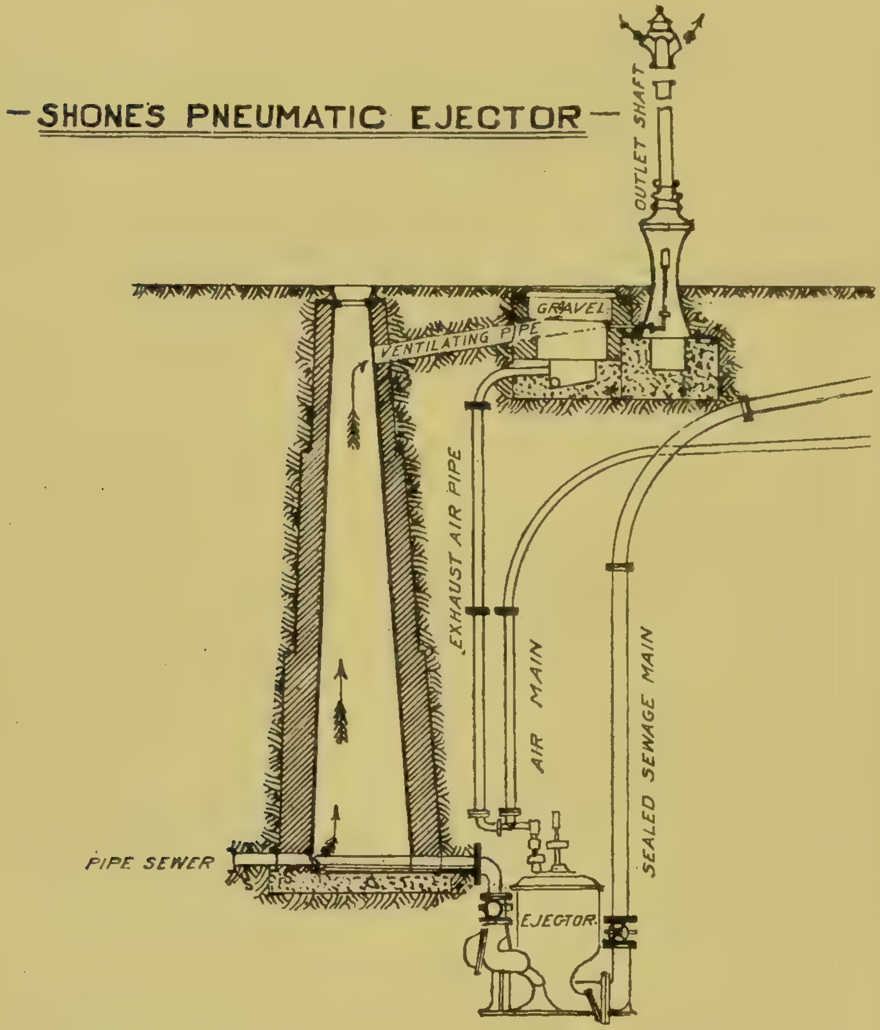
The minimum depth at which sewers should be laid will depend upon whether it is necessary to drain the cellars of houses; as a rule, 10 feet from the surface of the road to the invert of the sewer is sufficient. Iron pipes laid on concrete may be used when the sewers are near the surface. When the sewer is 15 feet deep, earthenware pipes should be cased in concrete.

No sewer should be less than 6 inches in diameter. The size will depend on the amount of sewage and rainfall and gradient; the internal sectional area can be thus calculated.

In large sewers a less gradient is required than in small sewers to induce the same velocity, but the volume of sewage will be the greater in the large sewer.

A sewer 10 feet in diameter having a fall of 2 feet per mile, a sewer 5 feet in diameter having a fall of 4 feet per mile, a sewer of 2 feet in diameter having a fall of 10 feet per mile, and a sewer of 1 foot having a fall of 20 feet per mile, will all have the same velocity, but the volume of the sewage with the 10 feet must be 100 times that with the 5 feet sewer, and 25 times that with the 2 feet sewer, and 4 times the volume of sewage in the 1 foot sewer.

SHONE'S EJECTORS.



These ejectors are all constructed by Messrs. Hughes and Lancaster. They are made of varying sizes, from 50 gallon capacity upwards. In Bombay there are several working from 10 to 1,200 gallons capacity each.

An ejector consists of a spherically-ended container made either of cast or wrought-iron and placed in a brick-work chamber, or in a cast-iron tubing. The working of an ejector is very simple.

The sewage enters by gravitation through the pipe A passes the flap G, and enters the container. The sewage rises until it reaches the underside of the bell D; the air within the bell is then enclosed and the sewage continuing to rise compresses the air until it can raise the bell D, with the rod and cup B, sufficiently to slide the valve E, so as to admit air from the air main. As soon as the air is admitted, it is free to act on the surface of the sewage in the container. The pressure so applied closes the back pressure-valve F into the pipe C, and then into the sealed sewage main, the sewage being thus driven out of the ejector.

The sewage in the cup B cannot, however, escape, and its weight, when the sewage falls below the cup, is sufficient to lower the spindle with the bell thereby re-sliding the valve E, so as to close the mouth of the air-supply pipe, and open that of the exhaust pipe, through which the compressed air in the ejector escapes into a shaft hereafter described.

The outer valve F then falls into its seat owing to the weight of the sewage in the sealed sewage main and retains the liquid in that main, and the ejector commences to fill again.

This process is repeated automatically so long as there is any sewage to flow into the ejector.

The compressed air for working the ejectors is produced in a central station, located in a position to suit all the ejectors and is conveyed to them in cast-iron pipes laid in the streets at a depth of some three feet, where they are free from all danger of breakage from traffic and steam rollers.

The advantages of the ejectors as given by the Patentees may be summed up as follows :—

(1) The working parts are reduced to a minimum and such as are requisite are not likely to get out of order.

(2) The parts with which sewage comes in contact contain no machine-tooled surfaces, which are unavoidable in pumps and get rapidly destroyed

by the action of sewage, sludge and grit from the road detritus, etc. In the ejectors there is nothing but the hard skin of the original castings, coated with Dr. Angus Smith's composition, upon which the sewage can produce no detrimental effect.

(3) The friction of a pump piston and other working parts is avoided, the compressed air itself acting direct upon the fluid, without the intervention of any machinery, and forming an almost frictionless and perfect piston, past which there can be no slip or leakage.

(4) The cup-and-bell float arrangement is one that cannot possibly get out of order, as an ordinary rising and falling float would be likely to do.

(5) The only tooled parts are those in connection with the small automatic air valve; this makes only one movement of two or three inches for each discharge of the container of from 50 to 1,200 gallons (according to the size of the ejector), and is in contact only with the compressed air and out of reach of the sewage.

(6) The sewage inlet and outlet valves are so arranged as to give free passage-way of the full area of the pipe, allowing free passage to all solids that the pipe itself can carry. No part of the container has any depression or traps wherein solid matter can collect.

(7) The outlet is from the bottom of the ejector, so that the whole of the sewage, including solids, sludge, grit and everything brought down the sewer, is discharged out of the ejector.

(8) For these reasons no screening or straining of the sewage is necessary, as is the case with pumps, and the great nuisance caused by the cleaning of pump gratings and sump wells is avoided.

(9) The sudden rush of the whole contents of the ejector, when the discharge is into a main gravitating sewer, forms a most effective flush.

(10) The ejector forms an absolute severance of the sewers of each district from the main sewer.

The size of an ejector required for any district is determined by the estimated quantity of the sewage of the district, its capacity being equal to the number of gallons of sewage per minute at the time of maximum flow, which, as is explained later, is one and a half times the average per minute of the total daily flow.

Each district should be provided with ejectors of the requisite size in duplicate, one being sufficient to cope with the ordinary work, the other being held in reserve. The two ejectors should be worked alternately, say, every week or fortnight, to ensure that they are both kept in working order.

Cast-iron pipes required for air and sealed sewage mains need not be of the same thickness as those used for water works, as the pressure under which they work is comparatively light.

DISPOSAL OF SEWAGE : CHOICE OF METHOD.

General Observations.

When the town is situated near the sea, the readiest method is the discharge of the sewage into the sea, well beyond the lowest ebb tide, by means of iron sewers. The point of the discharge should be away from the falling tide, and not above it.

In many of the seaside towns in England, the sewage is disposed of by discharging into the sea.

In large cities, as in Bombay, where the gradients are not suitable, there is difficulty of a continuous flow, and the sewage has to be lifted by the Shone system into the high level sewer and discharged into a reservoir and pumped up again into the sea.

In tropical climates, sewage decomposes so rapidly that a nuisance is caused by the accumulation of sewage in the reservoir, so that, in selecting the site, the direction of prevailing winds should be considered. Observations as to the set of the tide should be taken, by means of floats, to ascertain the direction of the currents.

PURIFICATION OF SEWAGE.

Sewage generally may be said to consist of a mixture of saline matter in solution and nitrogenous and carbonaceous organic matter in solution and suspension, together with a certain amount of grit and mineral matter. The objects to be aimed at in its purification are, the removal of the suspended matter and the oxidation of the remaining organic matter and ammonia.

There is a considerable amount of evidence to show that the oxidation of the organic matter, during its passage through filters or land, is chiefly a biological process, but as to the exact nature of the action which takes place very little is known.

It is practicable to purify the sewage of towns to any degree required, either by land treatment or by artificial filters, and there is no essential difference between the two processes, for in each case the purification, so far as it is not mechanical, is chiefly effected by means of micro-organisms.

The selection of a method of sewage disposal should depend primarily on local conditions.

The two main questions therefore to be considered in the case of a town proposing to adopt a system of sewage purification are, first, what degree of purification is required in the circumstances of that town and of the river or stream into which its liquid refuse is to be discharged ; and second, how the degree of purification required can, in the particular case, be most economically obtained.

The choice of a scheme must depend on a number of considerations, but the Sewage Commission state in their report that they know of no case where the admixture of trade refuse with sewage makes it impracticable to purify the sewage either upon land or by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary.

TREATMENT OF SEWAGE ON LAND.

It is generally desirable to remove from the sewage, by a preliminary process, a considerable portion of the grit and suspended matter, before attempting to purify the sewage on land or by filters.

If a sufficient quantity of good land, to which sewage can gravitate, can be purchased at a moderate price, land treatment would usually be the cheapest method to adopt. In cases where only clay land is available, it would generally be cheaper and more satisfactory to provide artificial filters.

There are many cases where crude sewage has been passed over land, but the evidence shows that land treatment of rude sewage is liable to give rise to nuisance, by the accumulation of solids on the surface of the land. Moreover, in some cases these solids are apt to form an impervious layer and so impair the efficiency of the treatment.

Given conditions favourable to each process, there is little difference as regards cost between any of the different forms of tank treatment, when these are considered along with cost of subsequent filtration.

There is *no essential distinction* between effluents from land and effluents from artificially constructed filters.

Effluents from those soils, which are particularly well adapted for the purification of sewage, contain only a very small quantity of unoxidised organic matter, and are usually of a higher class than effluents from artificial filters as at present constructed and used. Effluents from soils, which are not well adapted for the purification of sewage, may often be very impure.

Volume of Sewage which can be treated on land.

Generally speaking, the evidence points to a maximum rate of 30,000 gallons per acre, or 1,000 persons per acre, with the best land after preliminary treatment, although some put the rate as high as 60,000 gallons per acre, or 2,000 persons per acre, under similar conditions.

With unsuitable land, such as clay, not more than 3,000 gallons per acre can be efficiently treated, even after settlement of the sewage.

Table showing the approximate areas required with different soils.

——	Direct to Land.		After Precipitation or Mechanical Settlement.		After Filtration on Bacteria Beds.	
	Ratio of population per Acre	Acres per 1.000 persons.	Ratio of population per Acre.	Acres per 1,000 persons.	Ratio of population per Acre.	Acres per 1,000 persons.
Broad Irrigation.						
Gravel ...	100	10	500	2	1,000	1
Light Loam...	100	10	500	2	750	1⅓
Heavy Loam.	75	13⅓	200	5	400	2½
Chalk ..	......	......	......	......	......	......
Peat	Unsuitable	Unsuitable.	Unsuitable	Unsuitable.	Unsuitable.	Unsuitable.
Clay	50	20	100	10	300	3⅓
Intermittent Filtration.						
Gravel ...	150	6⅔	500	2	1,000	1
Light Loam...	150	6⅔	500	2	1,000	1
Heavy Loam.	75	13⅓	300	3⅓	500	2
Chalk ...	......	......	......	......	......	......
Peat	75	13⅓	200	5	400	2¼
Clay	Unsuitable	Unsuitable.	Unsuitable	Unsuitable.	Unsuitable.	Unsuitable.

Intermittent downward filtration.—Broad Irrigation.

After the sewage has been screened and the suspended matter removed in tanks, either by subsidence or precipitation by chemicals, the sewage may be discharged on the land. *Intermittent downward* filtration is defined by the Metropolitan Sewage Commission as the concentration for short intervals of sewage on suitable land, as small as will absorb and cleanse it, not excluding vegetation, but making the produce of secondary importance.

The action of the soil on sewage is both mechanical and biological. The suspended matter is removed and the organic matter broken up by bacteria or nitrification. The nitrifying organisms feed on the organic matter of the sewage oxidising it.

The most suitable land is sandy, porous soil, but clay land can be broken up and made efficient. The surface of the land must be levelled, and the sub-soil under-drained with porous pipes, at a depth of 6 feet. The surface should be ploughed into ridges and set out in plots, and the sewage equally distributed, each plot having a rest of 18 hours out of the 24. Vegetables and grass can be grown. One acre is required for 2,000 persons if the sewage is chemically precipitated, but if it is not, one acre for 1,000 should be allowed. In India less land would be required. Evaporation is faster and much sewage would be required to cover the land. The effluent is sufficiently pure to be discharged into a river or stream.

Broad Irrigation is defined as the distribution of sewage over a large surface of ordinary agricultural land, having in view a maximum growth of vegetation consistent with due purification for the amount of sewage supplied.

The land should be a loamy soil and so situated that the fall should be from the town to the site selected, but sandy soil, gravel or clay can be so treated as to utilize sewage. Chalk soil is not desirable because of the fissures. After screening, the sewage should be brought to the land as fresh as possible and diverted to the different plots by means of carriers of earth or cement concrete, so that the sewage is properly applied.

One acre of land to 300 people is required by the Local Government Board, England, but much less is required if the sewage is precipitated before being discharged on to the land. One acre for 1,000 persons is sufficient. Much depends on the character of the soil and sewage. Vegetables and grass grow luxuriantly, and in India, especially, sewage farms if properly managed are very profitable.

In tropical countries, in the presence of sewage farms or irrigation lands, the nuisance caused by mosquitoes has to be considered and in laying out such farms and in their management this should have every attention.

Wells in the neighbourhood of Sewage Farms.

On general grounds, and quite apart from any scientific data, it would seem to be unsafe to sink any shallow wells in the neighbourhood of sewage farms, or to use water for domestic purposes from any such existing wells, unless the evidence as to the safety of the water were of a most convincing kind.

Deep wells sunk through an impermeable stratum are probably safe in the majority of instances, but wells not protected in this way, and sunk through fissured strata, cannot be relied on to yield a safe water supply, however deep they may be.

Chalk wells are, perhaps, the most dangerous in this respect, and a recent report by Dr. Copeman on an outbreak of Enteric Fever at Fulborn Asylum and a paper read at a recent meeting of the Epidemiological Society by Drs. Richards and Brinker serve to confirm this view in a striking manner. The latter mentioned that a culture of a special organism was poured into a "swallow hole" at a distance of about two miles from a well, and was recovered from the well water after 67½ hours.

PRECIPITATION.

Precipitation may be (1) by subsidence or sedimentation ; (2) chemical precipitation.

Sedimentation is quiescent or continuous, &c., merely averting the sewage and allowing the heavier particles to settle before passing on to land or over filter. The tank must be cleaned out frequently, at least once a week.

Chemical Precipitation.—The process is now considered only one form of preliminary treatment to land or biological system, and in the case of some sewage containing trade waste is almost essential and, as a rule, aids in the subsidence of suspended matter and facilitates filtration.

The usual precipitants used are :—

Lime either by itself, as milk of lime 10 to 15 grains per gallon of sewage, or in conjunction with ferrous sulphate 12 grains per gallon ; aluminia ferric 5 to 15 grains per gallon of sewage, A. B. C., aluminia ferric, blood, charcoal and clay, 50 grains per gallon, ferrozone 8 grains per gallon. The objections are the colour of the sewage, the supervision required in mixing, the cost and the disposal of the sludge.

Ferric sulphate and lime appear to give the best results. In tradewaste, where much fat is present, sulphuric acid is used, while in brewery towns lime is the precipitant.

The process of chemical precipitation is to a large extent mechanical : the precipitants produced by the chemicals used dragging down the suspended matter. A certain amount of chemical action takes place when lime is added, the lime combining with the carbonic acid and making an insoluble carbonate.

Time required for Settlement in Tanks.

Continuous flow with chemicals :	8	hours in tank.
Continuous flow without chemicals :	15	,, ,, ,,
Quiescent with chemicals :	2	,, ,, ,,
Quiescent without chemicals :	2	,, ,, ,,
Septic tank without chemicals :	24	,, ,, ,,

In India it is found that 8 to 12 hours is sufficient for septic tanks.

Production of Sludge :—On the average, domestic sewage contains about 35 parts per 1,00,000 of suspended matter.

Sedimentation Tanks.

All tanks are sedimentation tanks, but it is convenient to limit the expression to tanks in which the sewage is allowed to settle without the aid of chemicals, and from which the sludge is frequently removed.

In some cases the tanks are allowed to stand full and the supernatant liquid is drawn off by a floating arm. In other cases the sewage is allowed to flow through the tanks slowly, but continuously.

Quiescent Sedimentation :—Two to three hours' quiescence is usually sufficient to produce a tank liquor fairly free from suspended solids, but owing to the fact that some sewages contain a larger proportion, than others, of solids that settle very slowly, no general rule can be laid down as to the necessary period of quiescence. With this form of treatment the deposit in the tanks should be frequently removed.

Continuous Flow Sedimentation :—The amount of settlement effected does not depend upon the period of flow alone but upon a number of other factors. If the tank liquor is to be treated upon filters of fine materials, the period of flow should generally be from 10 to 15 hours. The tanks should be cleaned out at least once a week.

Septic Tanks.

The notion that the solid matter of sewage would be digested by passing the sewage through a sealed tank is by no means novel, but it does not appear to have had any extensive practical application until Mr. Cameron, who held the office of City Surveyor of Exeter, proposed the adoption of the "septic tank treatment" for that city. At that time it was claimed that the septic tank possessed the following among other advantages :—

That it solved the sludge difficulty, inasmuch as practically all the organic solid matter was digested in the tank.

That it destroyed any pathogenic organisms which might be in the sewers.

That sewage which had passed through a septic tank was more easily oxidised than sewage from which the solids had been allowed to settle, either with or without the aid of chemicals, in tanks which were frequently cleaned out.

As regards the first of these claims, it is now clearly established that, in practice, all the organic solids are not digested by septic tanks, and that the actual amount of digestion varies, to some extent, with the character of the sewage, the size of the tanks relative to the volume treated and the frequency of cleaning. The liquor issuing from septic tanks is bacteriologically almost as impure as the sewage entering the tanks.

Domestic sewage, which has been passed through a septic tank, is not more easily oxidised in its passage through filters than domestic sewage, which has been subjected to chemical precipitation or simple sedimentation.

No definite rules can be laid down as to how long a septic tank should be run without cleaning. In the case of small sewage works (serving populations of, say, 100 to 10,000 persons), the tanks should generally be allowed to run, without cleaning, so long as the suspended matter in the tank liquor shows no signs of affecting the filters injuriously. For larger works it would generally be advisable to run off small quantities of sludge at short intervals of time.

The rate of flow through a septic tank is a matter in which the needs of each place require special consideration, but at few places should the sewage be allowed to take longer than 24 or less than 12 hours to flow through the tank. In India 6 to 12 hours is sufficient. In no case should less than two tanks be provided, and they should be so arranged that, if necessary, one tank can be used alone.

As regards digestion of sludge and quality of the tank liquor, a closed tank possesses no advantages over an open tank. There is, however, less risk of nuisance if the tank and the feed channels to the filters are covered in.

By passing septic tank liquor through tanks of a size sufficient to hold about one-quarter of the day's flow, with the addition of from 2 to 3 grains of lime, per gallon, to the liquor, the suspended solids in the liquor are materially reduced, the offensive character of the liquor is largely destroyed, and a considerably larger quantity of the liquor can be treated per cube yard of filter.

Chemical Precipitation.

In the case of sewages which contain trade waste, and strong sewages from water-closets and towns, it is generally desirable to subject the sewage to some form of chemical treatment before attempting to oxidise the organic matter contained in it. In most cases careful chemical precipitation materially aids the deposition of the suspended solids and facilitates subsequent filtration.

No general rule can be stated with regard to the capacity of precipitation tanks. With continuous flow, an eight hours' rate is usually sufficient to produce a fairly good tank liquor from a domestic sewage of average strength.

If sewage is allowed to remain quiescent in the tank, two hours' settlement would usually suffice.

Relative cost of Different Methods of Tank Treatment.

In the absence of special circumstances favouring a particular plan, it would appear that there is very little difference in annual cost between the various methods of tank treatment, when taken in conjunction with the cost of subsequent filtration through percolating filters, assuming that the kind of filter adopted in each case is that which is best adapted to the particular tank treatment provided.

Sewage filters may be divided into two broad classes: contact beds and percolating filters.

Contact beds are tanks filled with some filtering medium. In this type of filter, the sewage is held up before it is discharged. The bed, after it is emptied, is allowed to remain empty for some time before receiving the next filling. The length of time which the sewage is allowed to stand in the bed is spoken of as the period of contact.

In percolating filters, the sewage is not held up but is allowed to percolate through the filter.

There can be no doubt that the organic matter in solution in sewage can be oxidised by either type of filter, provided the filter is properly constructed and properly worked, but the question of the relative merits of the two types is one of some difficulty, as very few strictly comparative experiments on a large scale have been made.

Within ordinary limits, the depth of a contact bed makes practically no difference to its efficiency per cube yard. It would be generally inadvisable to construct contact beds of a greater depth than 6 feet or of a less depth than 2 feet 6 inches.

For practical purposes and assuming good distribution, the same purification will be obtained from a given quantity of coarse material, whether it is arranged in the form of a deep well or of a shallow percolating filter, if the volume of sewage liquor treated per cubic yard be the same in each case.

CONTACT BEDS.

Our knowledge of the action of a contact bed is very incomplete, and little is known as to the manner in which the organic substances of sewage are broken down, during the first stages of fermentation, into carbon dioxide, ammonia, &c. The purifying agents seem to be not only bacteria, but also worms, larvæ, insects &c., and no opinion can be offered as to the respective amount of work done by each set of agents. It probably differs to some extent according to the nature of the sewage. It has been observed that at some places large numbers of worms are present, while at others there are comparatively few.

Little is known of the kind of bacteria essential for purification, or as to their mode of action, and it cannot be stated whether they act chiefly during the period of contact or during the period of rest, or aeration after the filter is emptied. There are, however, grounds for thinking that the resting period is the more important phase of the cycle.

The generally accepted theory, as regards nitrogenous matter, seems to be that the ammonia is extracted from the liquid during the period of contact and oxidised during the period of rest, and that the resulting nitrate and nitrite are diffused through the liquid of a subsequent filling. All the ammoniacal nitrogen, however, does not appear in the effluent in the oxidised state, for there is always loss of nitrogen, as nitrogen gas, during the process.

The withdrawal of suspended and colloidal matter from the sewage during its passage through the bed appears not to be a simple mechanical effect of the material, for a matured contact bed, not clogged, will withdraw more suspended matter from the sewage than another bed similar in all other respects but not matured.

Construction of Contact Beds.

In some cases contact beds have been made by simple excavation, but the evidence shows that in the majority of cases it is desirable that the beds should be constructed of building materials.

Single contact will, generally, only yield a good effluent where the sewage to be treated is weak, and then only after good preliminary treatment. For the purification of partially settled weak sewage, and of well settled as also of partially settled sewage of average strength, if the case is one in which a good effluent is required, double contact is necessary, while if a strong sewage has to be treated triple contact is necessary, unless the preliminary treatment is exceptionally good.

In nearly every case a greater rate of filtration per cube yard can be adopted, if the material is arranged in the form of a percolating filter than if it is used in contact beds. In many cases the rate of filtration through percolating filters may be double or nearly double what it could be with contact beds.

Filtering Material.—The materials in general use for contact beds are clinker and coke; experience of other materials is not very great.

With percolating filters, however, many different materials have been used, and although the actual working of percolating filters is different from that of contact beds, the results are, to a large extent, applicable. At York a quantitative experiment with septic tank liquor was made on a circular percolating filter, 7 feet 8 inches deep, and constructed in four segments, one of clinker, one of coke, one of slag and one of broken brick, the material in each case being broken and riddled as nearly as possible to the same size; the bulk of the clinker was, however, distinctly smaller than of the other three materials. The results showed that the best effluent was obtained from the clinker segment, that the coke and slag segments gave very similar effluents, but not quite so good as the effluent from the clinker segment, and that the effluent from the broken brick segment was the lowest in the scale of purity. All four effluents were of good quality.

With percolating filters there is apt to be nuisance from flies, especially with filters constructed of coarse filtering material. In the warmer months of the year, such filters swarm with numbers of the psychodidæ, which, though appearing to breed and develope in the filters, may usually be seen in large numbers on the walls of houses or buildings close to or on the works.

Size of Material.—The smaller the size of material used in a contact bed, the greater is the internal surface area exposed, and consequently, the more intimate the contact of the liquid with the material, the greater the purification and the more efficient the arrest of the suspended and colloidal matter.

The efficiency of a contact bed, however, depends very largely upon the admission of air to all parts of the filter during the time the bed is resting empty. Thorough and rapid drainage is therefore of the utmost importance.

With regard to percolating filters of fine material, if the liquid to be purified were absolutely free from suspended and colloidal solids, and if thorough aeration could be maintained, the statement just made for filters of coarse material might possibly hold good for filters of fine material also. In practice, however, these conditions can scarcely be maintained with large rates of flow, and the greatest efficiency can be got out of a given quantity of fine material by arranging it in the form of a shallow filter rather than of a deep filter. But it is difficult to make an exact quantitative statement as to the difference in efficiency of the two forms.

The amount of sewage which can be purified per cube yard of contact bed or of percolating filter varies, within practical limits, nearly inversely as the strength of the liquor treated. This statement is based on the assumption that the size of the material of which the filter is composed is, in each case, suitable to the character of the liquor treated, and that the material is arranged at the proper depth to se cure maximum efficiency.

Percolating filters are better adapted to variations of flow than contact beds. Effluents from percolating filters are usually much better aerated than effluents from contact beds, and, apart from suspended solids, are of a more uniform character. On emptying a contact bed, the first flush is usually more impure than the average effluent from the bed. The risk of nuisance from smell is, however, greater with percolating filters than with contact beds.

Where the liquor to be treated contains much suspended matter, it is usually advisable to construct filters, whether contact or percolating, with coarse filtering material. Where the preliminary treatment has effectively removed the greater part of the suspended matter, it is best to use fine material in the filters.

As a rule, special stand-by tanks (two or more) should be provided at the works and kept empty for the purpose of receiving the excess of storm water, which cannot properly be passed through the ordinary tanks. As regards the amount which may be properly passed through the ordinary tanks in storm times, the rate of flow through these tanks may usually be increased without serious disadvantages to about three times the normal dry weather rate.

Tests for Sewage Effluents in relation to Standards.

According to our present knowledge, an effluent can best be judged by ascertaining, first, the amount of suspended solids which it contains, and, secondly, the rate at which the effluent, after the removal of the suspended solids, takes up oxygen from water. In applying this test, it is important that the suspended solids be removed and estimated separately.

The Sewage Commission report remarks:—"For the guidance of Local Authorities, we may provisionally state that an effluent would generally be satisfactory if it complied with the following conditions:—

1. That it should not contain more than 3 parts per 100,000 of suspended matter; and,
2. that, after being filtered through filter paper, it should not absorb more than
   - (*a*) 0·5 part by weight per 100,000 of dissolved or atmospheric oxygen in 24 hours.
   - (*b*) 1·0 part by weight per 100,000 of dissolved or atmospheric oxygen in 48 hours.
   - (*c*) 1·5 parts by weight per 100,000 of dissolved or atmospheric oxygen in 5 days."

Effect of Trade Effluents on Sewage Purification.

All the trade effluents interfere with or retard processes of purification to some extent, but the admixture of trade refuse does not make it impracticable to purify the sewage upon land by means of artificial processes, although in certain extreme cases special processes of preliminary treatment may be necessary.

Nuisance from Smell.

All sewage works are liable, at times, to give off unpleasant smells; they should therefore be situated away from dwelling houses, wherever this is practicable.

The nuisance is apt to be considerably greater where the sewage contains brewery refuse in any quantity; but, on the other hand, the presence of some trade effluents, such as iron-salts or tarry matters, tends to render the process of purification less offensive. The extent of the risk of nuisance depends, however, not only on the character of the sewage but also on the method of treatment adopted.

The points then to be considered, when advising on a biological system for disposal of sewage, are :—detritus chamber, septic tank, slate beds, contact beds, filter beds, effluents and outfall.

The sewage must be screened and passed into a septic tank, which may be covered or not. After remaining 8 to 24 hours according to climate, the supernatant liquor flows off and is distributed by mechanical distributors or sprinklers, or spread over a filter bed, or the sewage after being screened and admitted into a sedimentator tank passes to slate beds and filters and after sedimentation to contact bed and percolating filters, storm water filters being provided for the increase due to rain.

The contact bed may be upward contact and the liquor after being in contact with the coarser material is distributed by filtering trays or distributing gear over the percolating filter. The effluent is as a rule fit to pass into a river, but if the river water is used for drinking purposes it would be necessary that the effluent pass over land.

COMBINED REFUSE AND SEWAGE DISPOSAL.

It can now be determined, in the light of what has been stated under Incinerators or Destructors (in Chapter II), whether it will not be possible to utilise the town refuse in acquiring power for dealing with the disposal of sewage.

In England the steam and electricity derived from the heat evolved in destroying refuse are used for many purposes including the pumping of sewage and the working of the gear for distributing it over the filters and making the concrete for building the filters. In some towns the electricity is available for tramways and pumping water.

PRACTICAL APPLICATION OF THE FOREGOING.

In very few, if in any city in India at present, can a complete system of removal of sewage by water carriage be adopted. But in the majority a partial system can be installed with great advantage.

Let us take, for example, two cities in India : one with a population of about 50,000, the other with a population of about 120,000.

We are asked to advise on the best method of dealing with the sewage.

The cities are 1,000 miles apart in the Bombay Presidency. They are both situated close to rivers. One is peculiarly well situated as regards gradient, while the other is not so well favoured. The climatic and geological conditions differ. One has a scanty rainfall, is practically rainless, and has a high dry wind, while the other has an average of 29 inches per annum and during the rainy season is fairly humid.

The water supply in both cities is, or can be, made sufficient—in one case it is from a gathering ground, in the other from a river.

Beyond the primitive system of sewage disposal and sanitary arrangements they have nothing in common ; the following description of the system in vogue with slight modifications applies to both places.

At present the system of collection and disposal of night-soil and sullage water is most primitive.

The drainage system consists of innumerable open drains running either in the centre or sides of the streets and lanes into which drains from the houses run at right angles. These smaller drains passing along the streets and lanes are connected with main open drains, which discharge into private gardens the owners of which pay the Municipality for the use of the sullage water. The drains are badly made and laid and are constantly blocked and become full of sullage water and have to be swept by hand labour.

The privy system consists for the most part of open spaces, sometimes covered, chiefly on the ground floor of a house or in a blind lane but in some instances on the terraces. In many cases there are no seats or receptacles, the night-soil being deposited on the ground which is frequently unpaved. The excreta and urine and ablution water are also deposited on the bare ground : some is dried by the sun and some absorbed by the soil. Each privy has an open drain discharging into an open drain in the lane or street and is washed down by the *bhangi* after removing the night-soil. The open drains convey urine and some night-soil and ablution water into the main drain in the street and discharge into the outfall drains. All the washings from the houses and lanes, therefore, are discharged indirectly into open drains.

There are many *mahals* or groups of houses in which privies are placed common to several houses. These privies are in close proximity to the windows of the houses, the entrance to which is by narrow lanes. In many of the lanes the sun is excluded. The night-soil and urine, remaining for hours, soak into the soil or are washed into the open drains or to some extent dried by the sun.

Private privies are cleared by Municipal agency. All privies are not supplied with proper receptacles. Each *bhangi* has to clean fifty-five privies.

The privies generally abut on the open lane or street and, passing along the lane, the water from the bathing places and privies on the ground floor or upper floors can be seen discharging into open street drains. The narrowness of the lanes is accentuated by the presence of the open drains which occupy a considerable part of the space meant for walking.

Night-soil is removed to the north-east of the city where it is buried in trenches ; each trench 200 feet long consists of seven partitions. It has been arranged to put the night-soil in each partition on each day of the week to facilitate early drying. Owing to the greater depth of trenches, drying takes a longer time. But the trenches have to be made deeper because of the limited space available. The dried night-soil in each trench is sold. For the removal of night-soil from the public latrines, *mahal* privies and private privies, there is a staff of *bhangies* with night-soil carts.

This system then is insanitary for the following reasons :—

The privy floors are connected to the open drains in the lanes.

The night-soil and urine and ablution water and bath water, if not removed, to some extent find their way into the open drain.

In these open drains, excreta, urine and sullage water remain close to living rooms and shops and form an obstacle to the traffic.

The night-soil and urine, if not removed, become a nuisance and danger to health. In many of the privies the floors are paved, and the *bhangi* after collecting the excreta washes down the floor into the open drain. The urine and ablution water cannot be removed, but must either soak into the ground or discharge into the open drain.

The defects in this system are that human excreta, as well as other foul matter, are constantly being exposed in these drains. These drains overflow and discharge into the streets and lanes. They encroach on the already narrow lanes and the sides become broken and defective by the constant traffic. The lanes are so narrow that any influence the sun might have is prevented.

The ideal at which practical sanitation aims is the immediate removal and disposal of all excrementitious and polluted matter from the neighbouring dwellings without hand labour.

The present system is in every respect contrary to this.

The presence of human and animal excrement near to the dwellings is a serious danger to health, apart from the obnoxious odour polluting the air in and around dwelling houses ; there is a great danger of spread of Cholera, Enteric, Diarrhœa, Dysentery, Phthisis and infantile intestinal diseases. The food and water and milk are in danger of pollution, either directly or indirectly by flies and vermin, while a damp, polluted soil constitutes an additional danger to health.

The native part of the town is thickly populated. The streets are narrow with long winding passages and the houses irregularly built almost touching each other across the narrow lanes.

The European quarters and Cantonment and the bungalows are in open compounds. The sanitary arrangements are on the dry system and have private sweepers. The bath and kitchen waste discharge into cess pits or pails which are emptied and used in the garden, or put in a cess-pit cart which conveys it to the trenching ground. The Cantonment has latrines and urinals on various principles, on the dry and wet system, dotted about at convenient but frequently very unsightly and unsavoury positions. The night-soil drops into pails and the urine separates into buckets and the contents are conveyed by drain carts to trenches or incinerators.

In the Cavalry Barracks the horse dung and litter have to be dealt with, and greater attention is necessary owing to the breeding of flies and mosquitoes.

As far as the European and Cantonment arrangements are concerned, as there is no system of sewage, the night-soil and waste are dealt with by the scavengering staff and can be properly supervised : much depending on the control and zeal of the authorities.

The European and Military population is about 3 per cent. of the whole.

In the foregoing Chapter the data required for forming an opinion are given and may be re-capitulated.

The population, geological position, class of people and trade, facilities for draining and disposal ; the cost of the system and connection of the houses ; the amount of water available per day per head of the population, the rateable value of the city and the annual income from all sources.

The question has been under consideration for 30 years in both places. Sanitary Engineers and other experts have drawn up schemes ; but lack of funds, want of pressure and passive resistance of the Municipality have deferred their application.

The Health Officer or the Civil Surgeon has reported on the necessity of doing something for improving the sanitary condition. The mortality is high, Plague, Cholera, Small-pox, Enteric and Diarrhœa are constant visitors, while Malaria is always present.

The water supply is from a gathering ground or river and is or can be made sufficient. The Health Officer has asked for and given good reasons for an increase in the staff ; an improvement in the sanitary arrangement of the houses, urinals and public latrines and a system of drainage to carry off the sullage water and sewage ; a septic tank installation with contact beds and percolating filters and effluent capable of being discharged into the river or on to a sewage farm.

The practical engineering and actual carrying out of the scheme is done by engineers and, although the financial aspect must be considered in advising on an improvement, it is assumed that the ways and means will be provided. Vested interests and weak administration interfere with and delay achievement—but this must be expected. It must not dishearten the sanitary official ; he must continue to press and push forward schemes for the improvement of the district.

In some towns in India, schemes have been proposed, drawn up and considered for over 30 years before anything has been done.

It is a well-accepted fact that the health of a community is improved by proper drainage of the soil and, although the locality is for the greater part of the year rainless and has the natural advantages of a hot sun and a high wind, the constant pollution of the soil by the sullage water from the open drains constitutes a serious danger, which the laying of underground sewers will materially reduce.

The advantages of an underground system of drains properly laid with sufficient manholes, inspection chambers, flushing tank and ventilation are : the immediate removal of all excrementitious and polluted matter without hand labour ; the soil becomes drier, the atmosphere purer and the surroundings of the houses cleaner.

In Indian towns where the habits and customs of the people have to be considered, an underground system with water-closets connected and installed as in Western cities must, to a certain extent, be modified to suit these conditions, but it is an accepted fact that in Eastern towns, in spite of the habits of the people and their disinclination at first to adapt themselves to water-closets, a great, if gradual, improvement is noticed.

It is argued that the water-closet is misused and becomes choked with stones, sticks, earth, rags, &c., and the system gets out of order and that a certain class of people will not use water-closets and that *purdah* women would be prevented from using them unless placed inside the house and that there will be a danger of sewer air entering the house.

Compared with the advantages of a water-closet system, these objections are trivial and have all been put forward before in other places.

A properly constructed water-closet can, in every case, be kept cleaner than any form of native privy. While the ablution water and urine and night-soil from these *nahanis* or bathing places can all be utilised for flushing the water-closet basins and drains. The sides of the receptacles can be kept clean and the walls of the building do not reek with the odour of stale urine and night-soil.

Practical experience shows that in public latrines frequented by all sorts of people, ignorant and wilfully careless, much trouble may be caused by the blocking of the drains by stones, sticks, rags and that a whole-time sweeper halalkhor must be engaged to flush and clean the basins ; and the form of water-closet most suitable is the trough with automatic flush tank and inspection chambers. The blocking of the drains and water-closets with stones, sticks, rags, &c., must be guarded against by warning the people and by supervision and by provision of proper inspection chambers.

The supposed danger of sewer air entering the house is over-estimated. In a locality particularly where the water-closet will be on the ground-floor, or detached from the dwelling, no such danger is to be apprehended.

A properly laid water-closet system affords no such danger as long as the water supply is sufficient and the traps and ventilation shafts, soil pipes and inspection chambers are kept in order. The hand labour of removal of night-soil is done away with and the sewage is carried away at once.

The advice, then, on the question before us is that, for the reasons given, a system of underground drainage properly constructed would be suitable to these two cities. Public latrines and urinals should be provided on the water carriage system. Water-closets should be provided for groups of houses with automatic flushing tanks and the waste water from baths and washing places used for flushing the drains.

A certain number of pail depôts should be provided to which night-soil can be conveyed from houses where water-closets cannot at once be installed.

The narrowness of the lanes and the congestion of the houses in the town proper naturally constitute a difficulty in dealing with the question of adopting any system of drainage, but there seems no immediate prospect of a scheme for widening these lanes. Looking at the present condition, we are distinctly of opinion that the underground system properly devised and carried out would be an improvement on the present arrangement.

On going over the different schemes, it will be seen that drains of varying dimensions can be brought up to within a few feet of most of the houses. Inspection chambers, man-holes and flushing tanks should be provided and the connection of privies could then be made.

The Cost.—Although the question of cost may be outside the sphere of the ordinary sanitary student in England, unless he be Surveyor or Sanitary Engineer or Builder, it is a very important factor in India and one that delays improvements; every one interested in sanitation should have, therefore, some idea of the subject so as to guide him in advising on any particular scheme.

Much depends on the geographical position of the locality, the gradient, distance, depth of sewer, nature of soil.

In one case a scheme for draining a town may cost Rs. 10 per head of population, while in another it may be Rs. 20

or more. In England the cost of a complete sewage system and disposal of sewage costs £1 per head of the population

The cost of installing a water-closet will be from Rs. 75 to Rs. 90 including tanks, cisterns, connection, &c., complete.

The cost of a house connection varies with the width of the road and depth of sewer. In the case of a street 30 feet wide with a sewer 6 feet deep, each connection will cost about Rs. 15.

The expense, if borne by the landlord of small houses in ordinary towns in India, is very high compared with the value of his property; and the cost of installing water-closets or converting privies into water-closets and making house connections should be shared by the Municipality and the landlord either by financial aid, loans or by spreading the payment over a period of time; every inducement should be offered. In many of the large towns in England the alteration of the old privy midden or pail into water-closets has been carried out in this way.

As already pointed out, it will be some time before the open drainage system and the discharge of sullage on to the sullage ground and the trenching of night-soil can be done away with, but the tendency of sanitary engineering in India is towards that end. The general arrangement of houses in the thickly populated towns and the distances between bungalows in the wealthiest parts render this costly, but it can be done by degrees.

To briefly summarise :—

The water supply should be increased to 25 gallons per head per day as a minimum.

The out-fall on which the sewage is to be discharged should be acquired and properly laid out for a biological installation and effluent to discharge on the land.

The town proper should be drained and sewered. The drains should be brought up to the houses.

Public latrines and urinals on the water-closet system should be provided and trough water-closets installed for groups of houses.

Bye-laws and regulations should be drawn up for the control of water-closets for private houses.

Financial assistance should be given to the landlord to provide water-closets and house connections.

Storm water drains should be provided according to the rainfall and position of the locality, bearing in mind the prevention of mosquito breeding places.

CHAPTER IV.

WATER.

Water, being a vital element of food, is a prime necessity of life. It assists in the building up of tissues, in the elimination of waste materials from the body and in regulating the temperature of the body under varying conditions of heat. It is composed of two elements, hydrogen and oxygen, in the proportion of two of the former to one of the latter. Water should be clear, transparent, tasteless and odourless, and, when viewed in small quantities, perfectly colourless. When seen in bulk, however, it possesses a greenish blue colour. Practically speaking water is incompressible, but the volume of any given weight varies largely with the temperature.

As a general rule, fluids at all temperatures between their freezing and boiling points expand when heated and contract when cooled, but water is an exception to this rule, as in freezing it expands about $\frac{1}{11}$th of its volume. Its maximum density is at 4°C., and if cooled below or heated above that temperature it expands. The standard density of water is fixed at 4°C. in France, and at 60°F. in England.

The freezing point is 0°C. or 32°F., but if many salts are present the freezing point is lowered and the boiling point raised, the water moreover having a higher density than ordinary water. In freezing it becomes purer as it loses some of its saline constituents and air; ice water therefore is badly aerated and heavy. Water boils at 100°C. or 212°F. at the ordinary barometric pressure, but if the pressure be reduced, *e.g.*, by ascending a mountain or by placing water under an air-tight globe, the pressure of air in which is reduced by an air exhaust pump, it will boil at a lower temperature and can even be made to boil at the ordinary temperature of the room if the pressure of the air above it in the globe be reduced sufficiently.

Water evaporates invisibly at all temperatures, the amount being influenced by various factors to which reference will be made later. It is a remarkable solvent readily dissolving gases and solids from the air and soil. This is a most important fact necessitating precautions in a public or private supply. Oxygen, nitrogen, ammonia, hydrochloric acid, carbonic acid, etc., are easily absorbed. In addition to this power, it may hold in suspension mineral matters such as clay and sand, and also organic matter, *e. g.*, the lower forms of animal and vegetable life ; finally, water may dissolve certain metals, *e. g.*, lead, iron, zinc.

When bodies pass from the solid into the liquid state or from the liquid into the gaseous, a large quantity of heat is absorbed or rendered *latent*, thus water at 0°C. equals ice at 0°C. plus the latent heat of liquifaction. For example, if equal weights of water, one at 0°C. and the other at 100°C. be mixed, the mixture will have a temperature of 50°C., but if equal weights of ice and water, the former at 0°C. and the latter at 100°C. be mixed, the mixture has a temperature of 10·6°C. only. So also steam at 100°C. equals water at 100°C. plus the latent heat of vaporization, and to convert water, say one pound of it, at 212°F. into steam at 212°F. as much heat is required as would raise 965.7 lbs. of water one degree.

Water has a greater latent heat than any other substance, *i.e.*, more heat is spent in rendering a given quantity of ice liquid than in liquifying a similar quantity of anything else. These factors have a great influence in checking excessive evaporation and the too ready freezing of lakes. Water has a high capacity for heat but is a poor conductor of it. The term *specific heat* means the amount of heat required to raise a unit mass of a body through one degree in temperature. In England the standard is one pound of a substance through 1°F. In France it is one kilogramme of ice cold water through one degree (cent). Weight for weight, water will absorb more heat than any other substance for the same rise of temperature. The specific heat of a substance is generally greater when liquid than when solid or gaseous, *e. g.*, ice has only half the specific heat of water. The latter increases with its temperature. The specific heat of a perfect gas does not vary with its temperature or its density. For a large number of simple substances the specific heat of equal weights is inversely proportionate to the atomic weight. In regard to solids the specific heat is greater at a high temperature than at a low one, except in the case of platinum.

SOURCES OF SUPPLY.

Natural waters may be classified as follows :—(1) Rain water; (2) surface waters, *e.g.*, rivers, streams, lakes and ponds; (3) sub-soil waters, *e.g.*, spring and well. From whatever source, however, our water supply comes, it is ultimately dependent for replenishment on the rainfall.

RAIN WATER.

For any given temperature, air will only hold a certain quantity of aqueous vapour or moisture, the higher the temperature of the air the greater will be the amount of vapour it will hold, and when it contains its greatest possible amount it is said to be saturated and the temperature at which saturation occurs is called the dew-point. Now, if air laden with moisture be cooled, a point will be ultimately reached when the atmosphere contains as much moisture as it can retain at that temperature, and if the latter be still further reduced then the surplus moisture is deposited as rain, mist, snow or dew.

Rain water carefully collected, far from aggregations of populations, is generally a very pure water, being as a rule soft and well aerated. Near towns it carries down with it many impurities, especially in the earlier portions of a downpour. Near large towns where coal fires are abundant, one may find in it traces of ammonium carbonate, nitrite and nitrate, and also nitrous and nitric acids and sulphurous and sulphuric acids, but as a rule free acids are not found in the absence of factories and large collections of private houses consuming coal. Angus Smith states that the sulphates increase in amount as we pass inland before large towns are reached, and that they are due to the sulphur in the coal consumed. He further states that the salts of ammonium increase in amount as towns increase; they come partly from coal and partly from decomposed organic substances. In the neighbourhood of the sea coast, rain carries down with it sodium chloride or common salt and also sulphates derived from the sea. As it nears the earth's surface, rain absorbs organic matter and carries with it many bacteria in suspension as well as pollen, spores of fungi, minute particles of straw, hair, animal excrement, and sand, etc. On account of the ammonia present the bacteria are apt to multiply rapidly, consequently when rain water is required for internal use it should always be filtered first.

There are certain objections to the use of rain water as a source of domestic supply, among which may be mentioned :-- 1. Its uncertainty. 2. The prolonged dry season experienced by some countries—this involves a very large reservoir. 3. Rain water is not very palatable, and lastly much depends on where the rain falls, *e. g.*, if it falls on to a roof it may be very contaminated owing to soot, dust, decaying vegetable matter and the excrement of birds.

In favour of rain water is the fact that, in general, it is very pure and it is well aerated and soft. If it is used as a source of supply for a household, it must be remembered that near manufacturing towns its reaction is frequently acid and it may therefore act on certain metals, in consequence of which fact it should not be stored in lead, iron, zinc, or galvanised iron tanks. Slate tanks with cement joints should be used, or, if the storage is on a small scale only, earthenware cisterns are good. Very large tanks should be of brick lined with hydraulic cement and every precaution must be taken to prevent the entrance of surface or sub-soil water and also the earlier portion of the rainfall, as this is usually foul from having washed the air and also the collecting surface. If the water is to be used for drinking purposes it must first be filtered. In Great Britain rain water is generally less pure than water from a deep well or spring because of the large amount of smoke, effluvia, excremental dust and products of animal and vegetable decay, etc. Where rain water is stored for domestic use, rain water separators can be fixed to the rain water down-take pipe. They allow the earlier portions of the rainfall to flow away, but after a time, by an ingenious valve working on a pivot and actuated by the rainfall itself the water is diverted into another pipe and passes to the storage cistern.

Now, part of the total rainfall that occurs, is evaporated again from the surface, part flows along to form rivers and lakes, and a third portion sinks into the soil vertically or obliquely through fissures or pores until it reaches an impervious stratum, and then either finds its way laterally to the surface in the form of springs or accumulates in the porous strata overlying the impervious layer where it may be reached by sinking wells.

The amount which sinks in depends on many circumstances, *e. g.*, the nature of the soil—in sand and gravel about 90%, in chalk 40%, in limestone 20%, and in clay none. Further, obviously the proportion which sinks in is less in hilly districts where the water flows away freely. In winter a larger amount runs off the surface by gravitation than in summer, when by reason of the increased temperature evaporation is larger and the absorbent properties of the earth somewhat greater.

Experiments carried out by Tudsbery and others over a period of 14 years gave the following results as regards loss by evaporation.

The evaporation from the surface of water exceeded the rainfall in 3 out of the 14 years. The average results of the 14 years were :—

	EVAPORATION.		
Rainfall.	Soil.	Sand.	Water.
25·7	18·1	4·3	20·6

The small amount of evaporation from sand presents a marked contrast to that from the less permeable soil.

The mean daily average in England is 0·08 inch and in India 0·20 inch reaching even up to 0·56 inch in 24 hours.

Throughout the year the average evaporation from roofs may be taken as 20-25% of the rainfall, being greatest where the rainfall is least.

The loss by evaporation from lakes providing water to Bombay City during the 8 months of the dry season may be taken as under:—

Vehar	..	1,700 Million gallons.
Tulsi	..	250 „
Tansa	..	5,200 „

and for the remaining 4 months of the year one may reckon an additional loss of 25% more.

The average rainfall in Great Britain is about 30 inches. In certain parts of Assam it is over 400 inches. At Mahableshwar, Bombay Presidency, it is over 260 inches; whereas in certain other parts of the world rain seldom if ever falls *e.g.*, in the Sahara and in parts of the interior of Australia.

We may assume that about 6/10 of the actual average rainfall is available for storage, as a certain amount sinks into the ground—the exact amount, as has already been stated, varying with the rapidity of the rainfall, the compactness or porosity of the soil, the steepness or flatness of the ground, the nature and quantity of vegetation upon it, and the existence or otherwise of artificial drains. A certain amount also is lost by evaporation, the degree of which depends much on the temperature of the air and its dryness and rate of movement.

The following data in connection with rainfall may be of use to the Inspector to remember:—

(1) That one inch of rain represents about 101 tons of water per acre, *i.e.*, about 4·67 gallons per square yard.

(2) The following formula may be used to calculate the amount of water given by rain when the amount of rainfall and the area of the collecting surface are known:—

$$\frac{\text{Area in square feet} \times 144 \times \text{rainfall in inches}}{1{,}728} = \text{cubic feet;}$$

and one cubic foot of water = 6·23 gallons.

In calculating the receiving surface of the roof of a house, we need not take into account the slope of the roof but merely ascertain the area of the flat space actually covered by the roof.

a) Area of roof in square feet × ½ rainfall in inches = gallons per year. Or, (*b*) area of roof in square feet × rainfall in feet = cubic feet of water,

e.g.—roof space 55 square feet per head,

rainfall 27 inches = $2\frac{1}{4}$ feet,
then $55 \times 2\frac{1}{4} = 124$ cubic feet,
deduct 25 for evaporation = 99 cubic feet,
and $99 \times 6{\cdot}23$ = gallons 6·17 per head per year.

SURFACE WATERS—RIVERS, STREAMS AND LAKES.

Rain falling on hills and cultivated and uncultivated lands in part goes to form lakes and rivers. As a rule surface waters contain more dissolved matter than rain water. It is soft and the organic matters present are chiefly of vegetable origin. The chlorine present is low in amount; ammonia, nitrates and nitrites are generally absent except in such quantities as may be found in rain water; but if the surface water has come from cultivated lands which have been manured, then nitrates and nitrites may be present in considerable amounts. So also chlorides, if men or animals live on the collecting area.

Moorland waters may contain much peaty matter, sometimes in sufficient amount to cause Diarrhœa in the consumers; moreover, due probably to the presence of certain acids, such water may give rise to lead poisoning if the distributing pipes are of that metal.

If the surface water has passed over calcareous soil it may possess a considerable degreee of hardness. As a general rule upland surface waters are good and safe to drink and good for trade purposes.

River waters are derived in part from springs, in part from subsoil water and in part from surface waters. Snow, ice and floods influence rivers greatly.

The dissolved solids vary less than in spring water. They rarely exceed 30 to 40 parts per 100,000. As the water is derived from so many different sources, it is easy to understand that the different rivers vary in composition very greatly and the same river even, in the various portions of its route. This depends largely on the tributaries, which may arise in areas of vastly different geological formations to the main stream. The dissolved organic matter is greater than in spring water due to the influence of the surface water contribution ; this may come from cultivated manured lands or from farmsteads, etc. Also in times of flood much impurity of both animal and vegetable origin may gain access to the river. Further, when a river passes through a more or less thickly populated area it receives a great amount of pollution from household refuse and from factories, etc. Mining operations, especially lead mines, are often the source of much pollution.

In the Tropics where rivers frequently become completely or partially dried up during the dry season, there is a great risk of the bed of the stream becoming very foul from human and animal excrement and from the refuse matter of villages on its banks.

In India, and certain other countries, where sacred cities are to be found on the banks of certain rivers, there is an added risk in drinking water derived from such a source, owing to the custom, prevalent amongst the natives, of bathing in vast crowds in the river, and wrinsing their mouths with the same water in which their ablutions are performed while others go the length of drinking the same water. Very large numbers of pilgrims annually frequent these places and as Cholera is a most usual accompaniment of any gathering of people in India and the East in general, it is not difficult to understand that Cholera may be readily disseminated by such practices. Examples of this are seen annually at Nasik and Pandhurpur resulting in the subsequent infection of Bombay.

Generally speaking, the water of a river in the lower part of its course is less hard and more saline than the water of its upper tributaries, because the chalk held in solution by CO_2 is deposited owing to the CO_2 escaping into the air in the course of the river's flow.

Whether rivers are capable of self-purification has been the source of much controversy and the subject of many experiments. The evidence on the whole appears to favour the idea that they are.

The various agencies advanced to account for their purification include subsidence, dilution, growth of vegetation, oxidation, sunlight, natural water bacteria, and infusoria. The relative degree of activity of each element has not yet been satisfactorily ascertained but sunlight is unquestionably a very powerful factor.

River Water contains :—

1. Suspended matters of mineral, vegetable and animal origin. 2 Dissolved gases—nitrogen, carbon dioxide, and sometimes sulphuretted hydrogen. 3 Dissolved solids, lime, magnesia, soda, and potash, iron and aluminium in combination with chlorine, sulphuric, carbonic, phosphoric, nitrous and nitric acids.

The following is a very rough method of estimating the yield of a stream :—Take a part of the stream where the channel is more or less uniform in breadth and depth. Find the average breadth and depth in four or five places. Find the mean velocity of the stream in feet per second, this is usually about $\frac{4}{5}$ the surface velocity and is ascertained by noting the length of time taken by a float in mid-stream to traverse a given length of the river. Now multiply the sectional area by the mean velocity and the result is the flow in cubic feet per second; and cubic feet × 6·23 = gallons of water.

To roughly estimate the amount of water passing through a sluice :—

Find the area of the sluice and multiply this by $5\sqrt{\text{head}}$ in feet and the result is in cubic feet of water per minute.

The area of the sluice is the breadth multiplied by the height of the opening, both to be reckoned in feet or fractions thereof.

The head varies according to whether the sluice is or is not under water. If under water, then the head is the difference in level between the water above and below the dam. If not entirely under water, then the head equals the height of the water in the dam above the centre of the sluice. All measurements to be reckoned in feet or fractions thereof.

Lake water is water which owing to the configuration of the country–side has accumulated in such quantities as to form a considerable collection. *Springs* may also contribute a share in their formation. The water is usually soft and the nitrogenous matter may be considerable.

SUB-SOIL WATERS—(1) SPRINGS AND (2) WELLS.

(1) Springs or outflows of water from the earth are of two kinds:—(*a*) *Land Springs* are formed by the percolation of water through superficial porous soils such as sand, gravel or alluvial earth overlying an impervious stratum such as clay. If, when these two strata (the pervious and the impervious) come to the surface, the line of junction be tapped a land spring is formed : as the impervious stratum below throws out the water from the pervious stratum above by hindering its further descent and causing it to flow out laterally. Such springs are usually found on the face of slopes; they are uncertain and precarious as a source of water supply, as their output depends on the extent of the available porous collecting area. They are replenished by heavy showers which do not appear to affect deeper springs and wells ; in consequence they are liable to become dry in prolonged dry periods. If the porous layer in one particular spot is situated too deep, a pocket may form and the level of the water in the pocket sink below the level of the outcrop in periods of draught and the spring cease to yield until a prolonged rainfall occurs.

(*b*) *Deep springs* are those in which the source is the rain water percolating through great thickness of porous rock overlying an impervious stratum and the presence of some fissure or fault in the overlying stratum permits of the water below it rising to the surface. Frequently, the actual collecting area is at some distance from the spring itself. Such springs are met with in chalk and greensand. As the water has generally been well filtered, it is usually of great purity if surface drainage is excluded. The water is sparkling and palatable. They are preferable to land springs on account of their greater constancy and less liability to pollution. The character varies with the source. Water from Devonian rock, mountain limestone, new red sandstone and chalk may be too hard for domestic purposes.

(2) Wells are of two main varieties, shallow and deep. The distinction between them is differently interpreted by different people. Some term any well over 50 feet deep as a deep well irrespective of the strata through which it is sunk, while others restrict the term to those wells only which pass through some impervious stratum to a water-bearing layer beneath. This latter definition is the more generally accepted one.

Shallow Wells.

A superficial or shallow well is a well which derives its water from a permeable stratum overlying an impermeable one, but not in itself overlaid by such. The water from such a source is always more or less suspicious and in many cases distinctly bad. For convenience wells are often sunk in the immediate vicinity of habitations, stables, etc. In Bombay City there are some thousands of wells sunk in the ground floor of houses.

There are many sources of possible contamination, under the circumstances, usually associated with superficial wells, *e.g.*, the ordinary impurities of the soil of towns, leaking drains, cesspits and cesspools, middens, neglected basket privies, manure heaps of stables, pig styes, burial grounds, decaying vegetables and animal matter. The habit of performing personal ablutions and of cleansing garments at the mouth of insufficiently protected wells is also a source of risk.

As the rain water penetrates the ground it tends to descend until, sooner or later, it meets an impervious stratum which arrests its downward movement and tends to divert it laterally, and as the subsoil water steadily moves in the direction of its natural outflow depending on fall of the stratum in question, the location of any cesspool, stable, burial ground, etc., above the well must naturally lead to contamination of the latter, depending of course on the distance away and on the amount of demand made on the well and porosity of the soil in question. Another frequent source of possible contamination is the custom of using private vessels to withdraw water from a well; with an ignorant and careless people much pollution may thus be introduced.

The Koas system of drawing water from a well also leads to contamination of the water, owing to the amount of dirt which must necessarily adhere to the rope as the bullocks walk backwards up the incline leading to the well.

Again, the custom of planting trees in such a position as to overhang wells results in pollution of the water by decaying vegetable matter.

The organic matter found in superficial well water is generally of animal origin. Water which has soaked through sand and gravel may be impure from contained ammonia, chlorides, nitrates, and nitrites.

It must always be remembered that the source of pollution may be situated at some considerable distance from the well or spring. Leaking cesspools, manure steads, human excrement, etc., may through faults in the strata etc., discharge a portion of the contamination into a well far away. There are various methods of detecting any suspected source such as this. Chemical substances are introduced at the suspected source and their presence in the well water is subsequently looked for, after having taken the precaution of ascertaining that none of these substances existed in the water prior to the experiment. Lithium chloride, fluorescin and common salt are the substances most usually employed. The presence of lithium in the well water is ascertained by the spectroscope, that of salt by the silver nitrate test, and that of fluorescin by the fact that this substance gives a green fluorescence in the presence of an alkali. Dr. Beam of the Gordon College, Khartoum, has introduced a very delicate test for the slightest trace of this substance. He found that the concentrated water of the Nile was too highly coloured to permit of accurate observation under the method usually employed. His method is as follows:—Evaporate one or two litres of the water to small bulk and add a few drops of caustic soda and then over a water bath continue the evaporation to dryness. Now add 5 to 10 c.c. of strong alcohol and heat the dish, bringing the alcohol into contact with all parts of the water residue. The liquid is now passed through a small filter. In the absence of fluorescin the alcohol remains perfectly colourless, but if this substance is present a distinct fluorescence is imparted. McCrae and Stock, experimenting in South Africa, placed fluorescin in the suspected area of contamination and pumped the neighbouring wells. They prefer a dark background to detect the fluorescence. They noted that the water required to be concentrated before the test is successful; further, that the addition of an alkali is essential, as the characteristic fluorescence is not seen in acid solution. The green colouration sometimes produced by iron must not be mistaken for that of fluorescin.

Instead of chemicals, occasionally comparatively harmless species of bacteria are introduced for the same purpose, *e.g.*, the bacillus prodigiosus, and its presence is subsequently sought for in the well or spring water.

A well drains an area like an inverted cone, the radius of which is equal to at least 4 times the depth of the well. If the well be too much drawn upon by pumping, then this area of drainage is greatly increased, thereby adding to the risk of tapping some source of contamination such as a cesspool, manure stead, etc., situated some considerable distance away.

A sudden rise of ground water may cause direct communication between a shallow well and a cesspool not previously tapped.

In peaty districts the water from such a well may be brown due to vegetable matter.

To very roughly estimate the yield from a well, empty the well and allow it to re-fill noting the time taken. Let the well represent a cylinder. The cubic contents of a cylinder are found by multiplying the area of the base by the height. The area of the base $= D^2 \times \cdot 7854$. This gives cubic feet and cubic feet multiplied by $6 \cdot 23 =$ gallons.

By this means one can roughly estimate how many gallons will be available in a given time.

Precautions to be taken in regard to superficial wells.

The well should not be closer to a drain than 4 feet for every foot in depth of the well, *i. e.*, a 25 feet well should be 2 feet at least away from any possible source of contamination. A well should be 200 feet from any cesspool or cemetry.

The ground for a radius of 30 feet round the mouth of the well should be cemented, or paved with stone slabs set in cement with a proper slope leading away from the well, and adequate provision must be made for carrying away any waste or surplus water falling on this surface, so as to prevent the water gaining access to the well and also to prevent the breeding of mosquitoes owing to the accumulation of stagnant water in the vicinity of the well. The actual edge of the well must be protected by coping stones at least 2½ feet high to prevent access of surface water to the well. No private vessels should be used for abstracting water and, where the water is for domestic use, it should not be withdrawn from the well by the usual village practice of employing oxen (Moat or Koas).

Trees should not be allowed to overhang a well or to be so near as to permit the leaves falling in.

The mouth of the well ought if possible to be closed not only to prevent the entrance of dirt, or dirty vessels, but also to obviate the risk of mosquitoes breeding therein. By far the best measure is to permanently close the well by a concrete covering, leaving only a small trap door for purposes of inspection and cleansing (which door should under ordinary circumstances be kept locked).

The well should be lined either with bricks set in cement with a backing of puddle or with earthenware tubes or cement or iron cylinders to prevent the entrance of water except from the bottom or near to.

Moreover behind the cement or brickwork lining, there should be a layer of puddled clay as an additional precaution.

A pump should be provided to raise the water.

In villages, etc., if possible, all shallow wells should be surrounded by an acre of uncultivated and uninhabited land, no privy or cesspool being allowed within this area.

Koch, recognising the danger of superficial wells in times of epidemics, strongly advises that existing shallow wells be converted into tube wells. He proposes the following method of conversion. The well to the level of high water mark should be filled in with pebbles and gravel, and above this, and reaching right to the top, should be placed sand. To obtain the water an iron pipe must be placed in the well extending down through the sand and gravel to the bottom. This tube is connected to a pump. By this means Koch claims that much danger from Cholera can be obviated.

As a general rule, the site selected for a surface well ought to be as far removed as possible from all sources of contamination, and in a direction opposite to the natural course of the subsoil water so as to tap it prior to its reaching any source of contamination present in the village.

Deep Wells.

As already mentioned, the term refers more to the fact that the well is sunk through one or more impervious strata rather than to any measure of its actual depth in feet. The water obtained is generally pure and free from organic impurities, provided proper measures are taken to render the upper portion impervious and to prevent he entrance of superficial water. The water varies in composition according to the strata it passes through.

In chalk the water is clear, sparkling, and wholesome. It contains calcium carbonate and carbon dioxide. In limestone and magnesium limestone it is good; it however contains more calcium and magnesium sulphate than that from chalk.

From granite, metamorphic and trap rock it is very pure. It contains some sodium chloride and carbonate and but little lime and magnesia.

From millstone grit and hard oolite the water is very pure, the salines present being chiefly calcium and magnesium sulphate and carbonate.

The term *artesian well* is applied by some to deep wells passing through an impervious stratum into a pervious and water bearing layer ; by others the name is reserved for those deep wells from which water actually overflows.

The temperature in deep wells increases about 1°F. for every 55 feet in depth below 60 feet, at which depth it is fairly uniform at 50°F. Deep wells should be lined with bricks, stone, steel, socketed wrought iron or steel pipes to a point at least lower than the lowest water level. If with brick, they should be hard, well shaped, and well burnt and laid in good hydraulic mortar. To exclude land and other springs, etc., concrete or clay puddle must be introduced behind this steining. The layer should be steined as far down as the top of the impermeable layer.

To calculate the rate of flow from artesian wells, lower a bottle of aniline fluid to a depth of say 500 feet and then electrically explode a cap and burst the bottle. The time required for the fluid to appear at the surface gives an accurate gauge of the velocity of flow and given the diameter of the pipe, the amount of yield can be calculated.

To increase the yield from a well already executed, one or other of the following measures is usually adopted :—

(1) Lower the water level in the well by pumping whereby the hydraulic depth for the inflow is increased.

(2) The bore hole may be deepened.

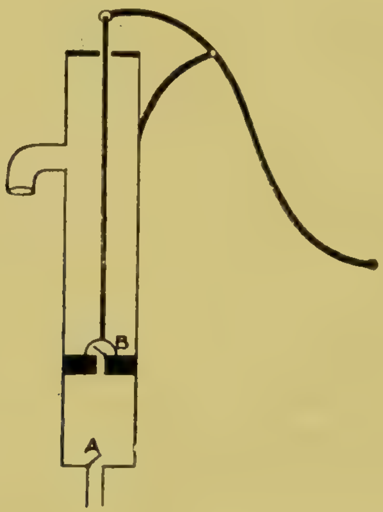
(3) Headings may be driven laterally from the well.

Abyssinian or Tube Wells.

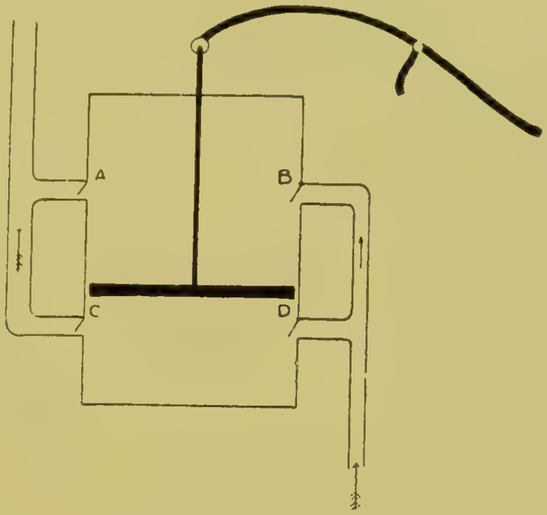
These consist of a hollow iron tube, of a diameter varying between 1¾ and 3 inches, which, at its lower end, has a steel pointed projection for the purpose o boring. The tubes are driven into the ground by heavy iron weights suspended on a pulley. The lower portion of the tube is perforated to admit of the entrance of water. A tube is driven in until a water bearing stratum is reached and if necessary successive lengths of pipe are at ached to the original. The water is derived from the stratum direct. Such wells are useful when the superficial supplies are known to be polluted. When a water bearing stratum is reached a pump is attached.

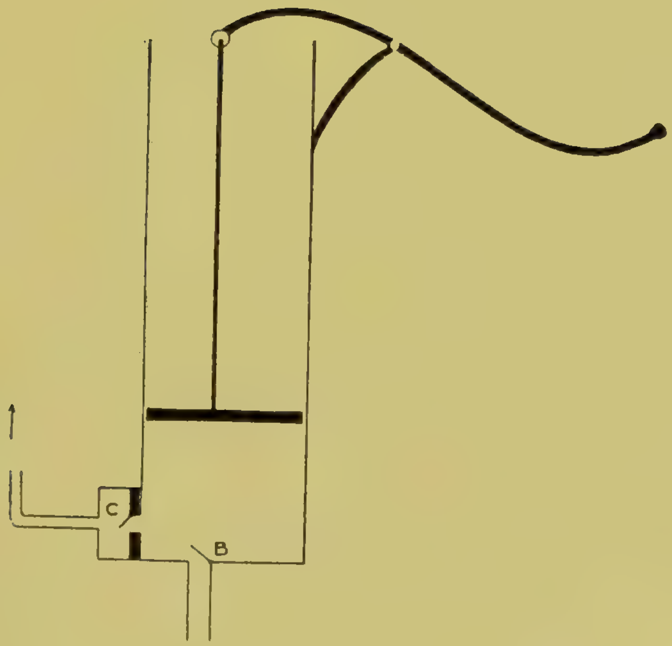
The insertion here of a few notes on the general principles of action and construction of various types of pumps may be of interest.

There are two types of pumps—the suction or atmosphere and the forcing pump. The former answers the purpose well, so long as the distance the water has to be raised does not exceed 25 feet.



The suction pump or atmospheric or lifting pump consists of a cylinder called the barrel, with a valve A in which works a piston or box in which is another valve B. Both valves open upwards. The piston is attached to a rod which is worked by a handle. When this is raised the piston is depressed. The valve B then opens upwards allowing the water or air below it to escape into the upper part of the cylinder. When the piston is raised the valve in it closes and the water above the valve is lifted up and discharged through the spout. The water from below owing to atmospheric pressure on its surface lifts the valve at A and rushes up to fill the vacuum caused by raising the piston. When the piston is again depressed the same process is again repeated. If the valves are very dry a little oil should be poured on them. A small quantity of water poured on the piston before commencing to work makes it air-tight. This form of suction pump is frequently used in shallow wells. It is suitable for hand power only. The surface of the water to be raised should not be more than 25 feet below the movable valve. Where the water level fluctuates, care must be taken to measure from the lowest level reached during those fluctuations. Especially for small pumps the suction pipe should fall all the way from the pump to the supply well, as





any upward bend in the suction pipe introduces an air trap and may seriously interfere with the power of the pump.

The Single Action Force Pump.

This pump is used to force water up to the top of high buildings, &c. In this pump the piston is made without a valve. The pipe for delivering water is at the bottom of the pump. It has a valve C which opens upwards so as to prevent the return of the water in the delivery pipe. At the bottom of the cylinder is a valve B opening upwards. Now when the piston is raised, valve B opens and the water rushes into the cylinder; when, however, the piston descends valve B closes and valve C opens and the water is thus forced up the delivery pipe. In this pump the force is required for the down stroke. The top of the cylinder need not be closed, as a little water poured in above the piston renders it air–tight. Sometimes a solid plunger is substituted for the piston to avoid the expense of turning the cylinder true and also because it resists the wear from dirt and grease better. At each stroke it raises a volume of water equal to that of the plunger.

The Double Action Force Pump.

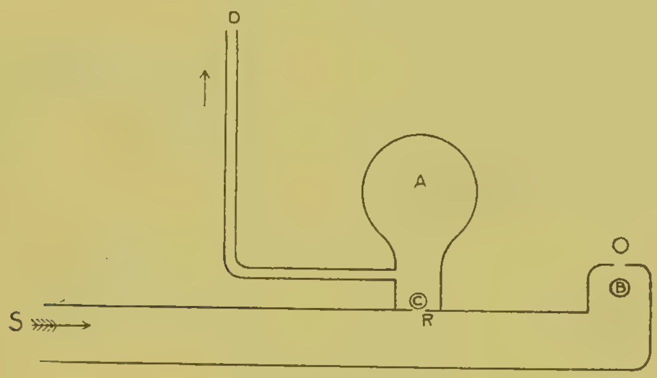
This pump forces up water both at the up and down stroke. At the up stroke the water above the piston is forced through the valve (*a*), while that below enters the cylinder at the valve (*d*). At the down stroke the water is forced through the valve (*c*), while it enters above the piston at the valve (*b*). In all force pumps the packing of the piston or box is of the utmost importance. It is commonly made of waste tow soaked in tallow rammed tight, but for great pressures cup leather packings are used.

Centrifugal Pumps.

These pumps contain no valves and no pistons. They work by the revolution of a series of blades contained in an iron casing. A partial vacuum is produced behind the revolving blade and water is drawn in due to atmospheric pressure upon it, whilst the water in front of the blade is forced into the rising main. These pumps are very good up to 25 feet. Some are made which are capable of raising water up 100 feet.

The Hydraulic Ram.

Rams are used to lift water to heights as a rule not exceeding 150 to 200 feet, but special rams are made for greater heights. The principle on which they work is as follows (*vide* Diagram):—The water working the ram is supplied through a pipe S and it escapes through the opening O until it has gained a velocity sufficient to raise the valve or ball B, which suddenly stops the current in this direction and causes an excess pressure in the ram R which results in the valve C being raised. The water is then pressed into the air chamber A and finally through the delivery pipe D to its destination. When equilibrium of pressure is established between S and R, the valve B falls and the operation is repeated. The ram depending on its size can make as many as 200 strokes per minute. The intermittent flow through C is converted by the pressure of the air in A into a constant flow in the pipe D. The length of the supply pipe may be ten times the height of the fall or more but it must not be less than 5 times the height. In ordinary cases the ram returns about 50 % of the natural effect, *i.e.*, the quantity of water × the height of the delivery above the ram equals about 50% of the quantity of water working the ram × the head of the fall in the same unit of time.



Any working fall from, say, 18″ up to 100 ft. will do to work a ram but the more the fall obtained up to about $\frac{1}{3}$ of the total height that the water has to be raised above the ram, the less will be the cost to raise a given quantity and the less will be the driving water required to lift that quantity. Rams will force water to a point several miles distant. The quantity of water required to work a ram depends on the fall available, the height it is required to raise the water and the quantity desired to be raised. Under favourable circumstances rams can be made to work with less than one gallon of water per minute. When giving the quantity of water available to work a ram, it is necessary to state also the velocity and flow in gallons per minute. When the working supply is not sufficient to work a ram continuously, the water may be dammed up and discharged at intervals: the ram thus working in an intermittent manner.

The ram is cheap and well adapted to small villages and country houses. The elevation to which the water has to be raised must not be too great, otherwise repairs to the working parts will be frequently needed.

In actual practice, it may be said, that water failing from any height between 4 and 40 feet may be made to raise a portion of itself to any greater height up to 10 times the amount of fall available.

A well-made ram is very durable and requires but little attention and its cost should not exceed £30 to £50.

Hardness of Water.

The provision of a hard water supply for a town reacts in various ways. In the first place a very great waste of soap occurs. The constant use of a hard water for drinking purposes causes gastro-intestinal troubles, vegetables boiled in hard water lose much of their colour and flavour. The same amount of nutriment is not extracted from meat nor flavour from coffee or tea, with a hard as with a soft water. Hard waters used in boilers may cause an explosion due to the deposition of salts, which usually occurs in the following order :—

1. The carbonates of calcium and magnesium.
2. The sulphates of calcium and magnesium.
3. Salts of iron, if present.
4. Silica or alumina, if present.

The incrustation formed causes much waste of coal.

The total hardness of most water is caused by salts of calcium and magnesium with some free carbonic acid ; hence waters from chalk, oolite, limestone, dolomite, and new red sand stone are hard. Rain water is soft.

It is estimated that every degree of hardness means a waste of soap to the extent of one pound of soap for every thousand gallons of water used.

Hardness of water is of two kinds, (1) temporary and (2) permanent ; the former is capable of being removed by boiling or by the employment of caustic lime or soda.

Temporary hardness is due to the presence in the water of the carbonates of calcium and magnesium held in solution as bicarbonates by carbonic acid chiefly. Salts of silica, iron and alumina, if present, may also add to the hardness. The bicarbonates of calcium and magnesium cease to be soluble at 212°F, and after treatment of the water with caustic lime or soda, as they are robbed of a portion of the carbon dioxide which holds them in solution, and they are deposited as mono-carbonates.

The permanent hardness is due to calcium and magnesium sulphate, chlorides, phosphates and nitrates with some magnesium carbonate which re-dissolves as the water cools. The salts of iron, silica and alumina, if present, also add to the hardness. All these salts are unaffected by boiling, thus constituting the difference between temporary and permanent hardness. To determine the amount of hardness present a solution of soap is used. Soap is a salt, the base of which is a metal and the acid, one of the fatty acids, *i.e.*, soap is an alkaline oleate, soluble in water forming with it a lather. If lime, baryta, alum, magnesium or iron be present, oleates of these bases are formed and no lather is given until the earthy bases are thrown down or used up. Free carbonic acid has the same effect. The precipitate formed with calcium comes down direct, but that formed by magnesium comes after a slight delay, hence an apparent lather may form only to disappear later. Many of the salts contributing to the total hardness are held in solution by carbonic acid, *e.g.*, the carbonate and some salts of lime and magnesium and some of silica, alumina and iron if present.

The amount of hardness may be expressed in terms of grains of calcium carbonate per gallon. This is known as Clarke's system, where each grain equals one degree Clarke, or it may be expressed as parts of calcium carbonate per 100,000. This is known as the metrical scale. When they are compared 1° Clarke=0.7° metrical.

The total hardness of a water should not exceed 30° metrical and of this the permanent hardness should not exceed 5° metrical.

Hard waters vary from 20° to 30° metrical and soft waters from 8° to 15°. A very soft water may contain from 6° to 8° metrical. The greater the permanent hardness the more objectionable the water.

Treatment of Hard Waters.

Temporary hardness can be dealt with by caustic lime or soda, which robs the bicarbonates of one molecule of carbon dioxide and reduces them to monocarbonates.

A water containing carbonate of magnesium :—

$$MgO + 2CO_2 + CaO = MgCO_3 + CaCO_3.$$

A water containing only bicarbonate of calcium :—

$$CaO + 2CO_2 + CaO = 2CaCO_3.$$

Water treated by caustic soda :—

$$CaO + 2CO_2 + 2NaOH = CaCO_3 + Na_2CO_3 + H_2O.$$

A water containing sulphate of lime can be dealt with by carbonate of soda, with the result that a monocarbonate of lime forms and sulphate of soda, a soluble salt, remains in solution.

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4.$$

A water containing both bicarbonate and sulphate of cal cium :—

$$CaO + 2CO_2 + CaSO_4 + 2NaOH = CaO + 2\,CO + CaO + Na_2SO_4 + H_2O = CaCO_3 + CaCO_3 + Na_2SO_4 + H_2O.$$

When the bicarbonate exists in greater proportion than 144 to 136 of the sulphate, the difference in excess must be dealt with by caustic lime.

One must know the exact degree of hardness in the water and use only so much lime, etc., as will combine with the carbon dioxide holding the chalk in solution—otherwise lime will pass out into the distributing pipes.

The average amount added is about 1 oz. of lime per 100 gallons of water for each degree of temporary hardness.

In the Porter-Clarke process the suspended matters are removed by passing the water under pressure through linen cloth. This process does not touch the permanent hardness.

For the reduction of permanent hardness the addition of lime, sodium, or sodium carbonate is necessary.

Action of Water on Lead Pipes, etc.

Certain waters act on lead and also on zinc.

Those waters which act most are—

- the purest and most highly oxygenated, *e.g.*, rain water, and the soft waters of lakes and upland surfaces ;
- those containing any organic matter, nitrites or nitrate from sewage pollution ;
- waters containing much of chlorides which dissolve the coating of carbonates which may have formed ;
- waters containing any free acid, *e.g.*, peaty water.

Water containing mud and mortar appears to act more on lead.

Those waters which act least on lead are—

- those rich in the earthy salts, *e.g.*, hard waters from deep wells containing carbonates, phosphates and sulphates, especially calcium carbonate : when sulphates are in excess they increase the solvent action ;

those containing free carbonic acid. If the CO_2 is in excess or the water is charged with it under pressure, then the coating of protective basic carbonate is dissolved and the solvent action of the water is increased.

Silica is said to have a protective influence.

New lead pipes yield more lead to the water than do old pipes. The length of time the water is in the pipe also influences the result: for the first 24 hours the amount dissolved increases, but afterwards some is deposited and after the lapse of about 6 days less is found. Hot water pipes take up more lead than cold. Increased pressure upto 140 lbs. per square inch helps the solvent action of the water. The juxtaposition of other metals to lead increases the solvent action owing to galvanic action; this is seen when iron, zinc or tin is mixed. Bending lead against the grain is said to increase the risk. Zinc pipes which often contain a mixture of lead may yield that metal to the water.

The amount of lead necessary to cause illness varies very greatly according to the personal idiosyncrasy of the individual concerned. Angus Smith quotes a case where water containing $\frac{1}{100}$ grain of lead per gallon caused poisoning. Adams also records a similar case. Any quantity over $\frac{1}{20}$ grain per gallon (*i.e.*, 0·07 per 100,000 parts) is to be considered as bad. As different observers report water analysis in different terms, *e.g.*, some in terms of grs. per gallon while others do so in terms of parts per 100,000, it is convenient to remember that to convert grains per gallon into parts per 100,000, one must multiply by 10 and divide by 7.

To prevent the absorption of lead various devices have been proposed, including acting on the water before it enters the pipe and acting on the pipe itself:—

1. Limestone, lime, or bicarbonate of soda are added to the water in order to lessen its acidity.
2. Lead pipes lined with tin have been recommended, but as the lining is liable to fracture, galvanic

action may be set up and lead dissolved. Block tin pipes besides being expensive are liable to corrosion if the water contains nitrates. Tin lined iron pipes have been used in many places. On the whole the best is to have good iron pipes protected in one of the various ways in vogue. Filtration through sand, charcoal, or spongy iron will remove much of the lead.

Action of Water on Iron Pipes.

The action appears to be energetic at first but diminishes later. Soft waters act freely on cast iron causing corrosion and consequent turbidity of the water and diminution of the lumen of the tube. Waters with little lime but high chlorides act rapidly on iron. They acquire a ferruginous taste and leave a deposit of red oxide of iron in vessels. Different methods have been adopted to protect iron pipes from corrosion.

Angus Smith's protective process consists in coating the interior of the pipe with a mixture of pitch. As a result the corrosive action of the water is lessened. The pipes are heated to 310°F and are then immersed in a bath of pitch for some time. This bath must be kept at a temperature of not less than 310° and the pitch used must be distilled until all the naphtha has been driven off the coal tar. To the pitch about 5 % to 6 % of linseed oil is added. The pipes must be perfectly clean and free from rust before immersion.

Barrf's protective process consists in raising the temperature of the pipes to 1200°F in a suitable chamber through which superheated steam is passed for several hours—after which treatment a coating of oxide is formed.

In some parts of the United States of America iron pipes lined with hydraulic cement are used.

On the whole iron pipes are best for the larger pipes required and under the pressure of the constant system for the smaller pipes also.

QUANTITY OF WATER REQUIRED PER HEAD OF POPULATION.

This must of necessity vary according to circumstances of climate, the presence of trades and large institutions, etc. Water is required for ordinary domestic purposes including personal ablutions, cooking, cleansing of the house and clothing and for water closets and baths. Municipal requirements must be met as water is needed for the streets, cleansing drains and sewers and for extinguishing fires. Provision must also be made for animals, *e.g.*, horses, cattle and dogs. Finally, trade requirements and an allowance for waste must be met. It is not possible to lay down any hard and fast standard of requirements; a rough guide, which however must vary according to circumstances, is for domestic, municipal, and trade purposes 10 gallons each per head. The following table shows the average allowance per head in each of the following towns:—

London	.. 35	Edinburgh	.. 38
Liverpool	.. 31	Dublin	.. 35
Manchester	.. 29	Bristol	.. 23
Glasgow	.. 50	Newcastle	.. 38
Paris	.. 44	Rome	.. 220
Berlin	.. 22	Calcutta	.. 35
Vienna	.. 22	Madras	.. 18
Bombay	.. 40		

In the case of Calcutta, Madras, Bombay and other towns the amount of water actually used per head is greatly in excess of the amount provided by the respective Municipalities, as a large amount of water is extracted from private wells and public tanks for ordinary domestic purposes, washing and for the watering of gardens.

In Bombay it is beyond question that a reckless waste of public water is practised by the poorer classes.

THE COLLECTION AND STORAGE OF WATER.

Where the water supply is derived mainly from surface waters, it is necessary to provide sufficient storage where any aggregation of population occurs, in order to meet the demands for water in the dry seasons. Water is therefore collected in what is known as an 'impounding reservoir,' which is usually constructed by damming the lower end of a valley.

Many considerations have to be weighed before settling on any particular site as suitable for an impounding reservoir, and though these fall more particularly within the duties of a Water Engineer, brief reference may be made here to a few of the main points.

(i) In the first place one must know the amount of rainfall experienced in the area under examination, its seasonal distribution, the greatest annual rainfall, the least and the average, and also the length of the dry season.

Hawksley has estimated that, speaking generally, the average of 20 years' rainfall less $\frac{1}{3}$rd may be taken as the amount of rain in the driest year, that similarly the average of 20 years plus $\frac{1}{3}$rd equals the amount in the wettest year, that the average of the 3 driest years in 20 is a fairly safe basis to work upon, and that this may generally be taken to be about $\frac{5}{6}$ the average rainfall. We may assume that about $\frac{6}{10}$ of the actual average rainfall is available for use.

(ii) The extent, configuration and nature of the catchment area must be carefully ascertained. The nature of the soil influences the loss by percolation, which is greatest where the soil is porous, *e.g.*, sand and gravel. A steep rocky surface occasions least loss by evaporation and percolation. The ground must be examined to ascertain the nature of the underlying impervious stratum and its distance from the surface and, if possible, the presence or absence of any fissures should be ascertained.

It is most desirable that no part of a catchment area should be under cultivation, nor should any human habitations be permitted in the area. The houses necessary for the Water Engineer's permanent staff should be so situated as to preclude any risk of drainage from them entering the lake. The area should be fenced in to prevent cattle straying into it and it should be covered by evergreen trees to protect the soil from being washed away.

(iii) The extent of the demand (if any) for compensation waters must also be ascertained and provided for.

The sides of reservoirs should slope rapidly and preferably should have a rubble-covering to a depth of 6 to 10 feet below low water mark. In very large reservoirs, however, this is often impracticable.

The margins should be kept free from weeds and long grass.

In impounding reservoirs the growth of chara and nitella may cause an offensive smell and taste to be imparted to the water. Soft waters and those with ammonia in them aid the growth of these low forms of vegetable life.

Blue and green algæ frequently grow along the sides and diatoms and desmids on the surface.

To destroy algæ, etc., copper sulphate in the strength of 10 lbs. for every million gallons of water is of great value. It is usually mixed with the water by towing canvas bags over the lake behind a small boat or boats.

The decay of blue algæ causes an objectionable smell, which also is noticeable when the oil sacs in them are ruptured. After water containing blue and green algæ has been treated with copper sulphate, the smell may appear to be worse, but in a week the water will be found to be quite free from smell, sediment and any trace of copper. Filtration through polarite removes copper as will also many mechanical filters, *e.g.*, Towells.

Water from reservoirs rich in bottom vegetable growths frequently has an offensive odour, for which the only remedy is thorough aeration.

A method of getting a very rough estimate of the amount of reservoir space required is as follows :—Divide the number of gallons of water used daily by 6·23 ; this gives the number of cubic feet consumed per day, and that multiplied by the number of days for which storage is required gives the reservoir space necessary. Hawksley introduced a formula whereby one can ascertain the number of days' supply that should be stored in any particular instance. Let F equal the mean annual rainfall in inches, say $\frac{5}{6}$ of the average annual yield, and let D equal the number of days for which storage is required, then

$$D = \frac{1{,}000}{\sqrt{F}}$$

e.g. the mean annual rainfall is 25 inches, then

$$D = \frac{1{,}000}{\sqrt{25}} = 200 \text{ days.}$$

In England the minimum number of days for which storage should be provided is usually about 150 days.

From impounding reservoirs the water is taken to storage reservoirs, from whence it may pass to filter beds, or in some instances direct to the consumer through street mains and service pipes, etc. Pumping stations and settling tanks may or may not be necessary, according to the elevation of the impounding reservoir and the purity of the water. As far as possible all storage reservoirs should be covered in and ventilated, they should be deep, and not extended and shallow,so as to lessen evaporation and keep the water cool. They should be periodically cleansed. Further reference will be made to the importance of storage reservoirs under the heading of "Purification of Water."

When the supply of water is derived from a river, the intake should be where the stream is constantly flowing, avoiding stagnant and shallow places. It is best situated some feet below lowest summer level. Screens should be provided to exclude gross matter entering. The water may have to be pumped to subsidence and storage tanks, passing thence to filter beds and to the clear water storage reservoir and thence to the public.

DISTRIBUTION OF WATER.

There are two main systems and several subsidiary methods of distributing water, such as by water carts, *pakhâls*, etc. The main systems are (1) the constant and (2) the intermittent, the essential difference between them being that in the latter there must be provision made in the house for the storage of one or more days' supply of water, whereas in the constant system the storage required is only to the extent of the cisterns necessary for the water-closets and kitchen boilers.

In the constant system, the taps in the houses deliver water direct from the service pipes. This system necessitates a good supply of water, good pipes and fittings and strong taps. Any wastage is generally due to leaks in the pipes, resulting from fracture and drawn joints or defective taps. Such leakages are generally detected by sight or by the use of waste-water meters. Among the objections raised to the constant system are the waste that may occur and the loss of control in times of shortage of water. The former can and should be controlled to a great extent by waste-water inspectors and by the compulsory use of strong fittings, and the latter is capable of control by curtailment of hours of supply should necessity arise.

The intermittent system is open to many objections: in the first place it causes corrosion of the pipes, resulting in diminution of supply and turbidity of the water.

The cutting off of the water tends to create a vacuum in the pipes; consequently, if there is any fracture in the pipes or leaking joint there is great risk of foul air or coal gas or even sewage being sucked into the pipes. In actual practice outbreaks of disease have been traced to this very cause.

The intermittent supply is in itself a great source of waste, as people leave the taps open on finding no supply on. Consequently, when the supply does come much waste may result.

Another very serious objection is that this system necessitates the use of cisterns for the storage of water during non-supply hours. Cisterns are apt to get foul, are costly and moreover the water is apt to stagnate in them and absorb impure air. Besides, in many of the homes of the poorer classes there is no room for cisterns. Where cisterns are necessary, they should be so placed as to be readily accessible for purposes of cleansing, which process should be carried out at regular intervals. They should be covered so as to keep out dust, insects, vermin and the droppings of birds, etc , and also to prevent the breeding of mosquitoes. Provision can be made for ventilation by means of a curved pipe. They should be placed at the top of the house and, if this be a high one, provision must be made for filling them by a force pump worked either by hand or by electricity.

No cistern supplying a water-closet should be allowed to supply the drinking water of the house as well. Here one may add that on no account should a tap from a service pipe ever be allowed to directly flush a water-closet.

Every cistern should be supplied with an overflow pipe opening directly into the open air, so as to give timely warning of any waste. This pipe must never open either into or over a drain or sewer.

Frost may interfere with the action of a cistern, and if the kitchen boiler is supplied direct from the cistern at the top of the house, much trouble may result from a severe frost such as is experienced in certain parts of India. A separate cistern placed at the back of the range should always be provided in places exposed to severe frosts.

Cisterns are constructed of various materials: stone, cement, brick, slate, tiles, wood and lead, zinc and iron, etc. Of these slate is perhaps the best, but it is liable to leakage; it should be set in hydraulic cement or in Spence's metal; common mortar should not be used as it may cause the water to become hard. Lead cisterns are open to the objection that certain waters act freely on them. Zinc and galvanised iron cisterns are liable to corrode, and if the water is rich in nitrates, zinc salts may be dissolved in the water. Wooden tanks should not be allowed. Iron cisterns are apt to corrode.

Spence's metal is made by melting the three sulphides of iron, zinc and lead with sulphur. It expands in congealing and so is very useful for jointing water pipes, etc.

SOURCES OF IMPURITY IN THE WATER SUPPLY.

These may have their origin in the geological strata from which the water is derived, or from the manner of storage or distribution.

Impurities from Geological Strata.

Mountain limestone yields a clear palatable water, which however is rather hard and therefore unsuited for many trade and domestic purposes. So also water from hard solite, cretaceous rocks, and chalk is hard. Water from magnesium lime-stone contains a large amount of permanent hardness. That from gravel is very variable and usually contains much organic matter. Shallow wells in alluvial and gravel soils generally yield an impure water, containing calcium carbonate and sulphate, sodium carbonate and chloride, magnesium sulphate and traces of iron and silica and often much organic matter. From cultivated land the water contains much organic matter and salts. The water of marshes contains much vegetable organic matter. Wells near cemeteries may yield a water containing ammonium and calcium nitrites and nitrates and sometimes fatty acids and much organic matter. That from old cemeteries contains less organic matter, but much nitrates and chlorides and speedily becomes putrid. Wells near the sea may give a brackish water. The impurities of rain water have already been referred to.

Impurities of Storage.

One of the great objections to the intermittent supply of water is that this system necessitates the presence of cisterns. These are very apt to become neglected and be a source of danger as already mentioned. Storage in underground tanks, which are not properly constructed so as to exclude surface drainage or drainage from leaking cesspools, also permits of pollution of the water. The material of which the tank is constructed may also have this effect. Open tanks are very liable to pollution from the habit of the people bathing there and washing their clothes therein ; moreover, many are so insufficiently protected as to permit of surface drainage gaining access.

Pollution during Distribution.

Distribution by means of open conduits is attended with considerable risks, as such are liable to be fouled by surface washings, leaves and branches of trees, dead animals, house and trade refuse and human and animal excrement.

The possibility of water dissolving iron, lead and zinc when passing through pipes composed of those metals or stored in cisterns thereof has been discussed elsewhere. Defective pipes and joints may admit of pollution, if water pipes are permitted to be laid in the viciniy of cesspools and drains, etc.

Sewer gas, sewage and coal gas may all be drawn into water-pipes when the intermittent system of supply is in vogue.

Distribution by Skins. (The mashak.)

Leathern receptacles made of the skin of the goat or calf are used.

The sources of pollution are more or less obvious, as the skins are unclean to commence with and cannot be made or kept clean. Moreover, during non-working hours the *mashaks* are deposited anywhere and, should an outbreak of Cholera or Typhoid occur in the house of the *bhisti*, the chances of infection of these receptacles are very considerable.

Distribution by Water Carts and Barrels.

The chief risk in such cases lies in the difficulty of keeping such receptacles clean. As a general rule, precautions are absolutely neglected and the carts become very foul.

Periodical cleansing and strict inspection tend to minimise the risk.

EFFECTS OF AN INSUFFICIENT OR AN IMPURE WATER SUPPLY.

The effects of an insufficient supply are more or less obvious. Personal cleanliness of body and clothing diminishes. Eating utensils are not properly cleansed. The cleanliness of the house suffers. The streets are not watered, increasing thereby the nuisance and danger from dust. The sewers and drains are not flushed, and these add to the vitiation of the atmosphere. The result of all these factors is a lowering of the general health: skin and eye diseases spread. Typhus, Enteric, Diarrhœa and Relapsing Fever increase. The danger from an outbreak of fire is also magnified in the case of a shortage of water.

The effect of an impure supply has been seen frequently and reported upon in detail. It is necessary here merely to mention the main diseases which may be caused by an impure water, without going into the evidence in support. Diarrhœa, this may be due to suspended mineral matters, *e.g.*, clay; marl, etc., examples of which may be seen in the effects produced on some by drinking the water of the Ganges and Mississippi. Suspended matters, animal and vegetable, and dissolved organic matters also cause Diarrhœa. Hydrogen, sulphide in solution and dissolved mineral matters, *e.g.*, calcium and magnesium sulphate and calcium and potassium nitrate also produce the same effect.

Cholera, Enteric, Dysentery, Dyspepsia, lead, copper, arsenic and zinc poisoning. Finally, certain parasitic diseases may be set up by means of water, the ova of the following being introduced by this means :—*Anky lostoma duodenale, Dracunculus medinensis, Distoma hepatica, Ascaris lumbricoides, Bothriocephalus latus, Oxyuris vermicularis and Bilharzia hœmatobium.*

THE PURIFICATION OF WATER.

The purification of water may be necessary in order to remove excessive hardness, suspended matters, dissolved organic matter, or for the removal of micro-organisms usually associated with disease.

Various methods are employed, *e.g.*, distillation, boiling, chemical agents, storage and filtration.

Distillation.

Distillation unquestionably produces a very pure water, which is soft as all the salines are removed. Its use is obviously restricted to comparatively small demands on account of the expense involved. It is essential that the receptacle into which the distillate is received be clean, and the water itself should be from a fairly clean source. Distilled water is not very palatable, owing to its lack of aeration; this can be remedied by passing it through a clean sieve or by pouring it from a vessel at a height into another receptacle.

Boiling.

Boiling renders the water safe, as all the organisms are destroyed, and, further, the hardness of the water is lessened. There are various patent sterilisers in the market, amongst others :—(i) *The Lawrence Patent Water Softener and Steriliser,* which claims the following advantages:—low first cost, and low working expenses, rapidity in action and great efficiency; no chemicals need be used, except occasionally a little sodium carbonate to lessen the hardness; great simplicity in working and in cleaning.

(ii) *The Ford Palliser Drinking Tank* was exhibited at Bisley in May 1904. It consists of a water-cart with appliances for rapidly boiling water in large quantities. The essential feature of this water-cart is a tubular boiler tank, heated by ordinary paraffin oil. 80 gallons per hour can be boiled while the cart is in motion, the tank being kept level by a gimballed arrangement. A second tank with interior cells containing a solution of saltpetre is connected with the boiler and is used for cooling purposes. It is claimed that it is of great service in supplying pure water to troops.

(iii) *The Waterhouse Forbes Water Sterilizer* is an American apparatus which has been recommended for use in the field. The advantages claimed are: (1) that the water passing through the sterilizer, although brought to the boiling point, is maintained at this temperature for so short a time as not to be deprived of its natural gases and hence it is not rendered unacceptable to the palate ; (2) that all micro-organisms except a few spore-bearing organisms are destroyed by the degree of heat attained ; (3) it can supply practically sterile water for 24 hours with one supply of oil ; (4) the water is afterwards cooled to within 4½ degrees (Fahr.) of its original temperature before entering the apparatus ; (5) it is durable in construction and it is easily put together, taken asunder and cleansed.

Chemical Processes of Purification.

1. *Alum* may be used in amounts varying from 2 to 6 grains per gallon. It has a good effect in clarifying the water, especially if calcium carbonate be present. It destroys ordinary water organisms but does not affect the pathogenic organisms, except in so far as the mere mechanical effect is concerned. A certain number of organisms are carried down with the precipitate that forms.

Alum does not act well when the water is very soft ; consequently, when such is the case, add a little calcium chloride and sodium carbonate first.

The addition of 5 grains of lime also considerably enhances the effect of alum.

2. *Sulphate of Alumina,* free from excess of acid and iron, is cheaper than alum and can be used instead of it in the proportion of $\frac{7}{10}$ of it to 1 of alum.

3. *Perchloride of Iron* is sometimes used instead of alum and for the same purpose. It leaves in solution chlorides instead of sulphates.

4. *Potassium Permanganate* is of great use in cases where the water is impure and foul smelling. It forms a precipitate of manganic oxide and carries down suspended matters. Some organic matter, both animal and vegetable, is oxidised. A solution of the crystals should be made before adding the chemical to the water.

It is advisable to supplement the potassium permanganate treatment by alum purification and if possible filtration may be added.

If the water is very soft, add calcium chloride and sodium carbonate. No definite quantity of permanganate is used, the custom being to add sufficient solution to make the water pink and retain its pink colour for about ½ hour.

For an ordinary sized well about 4 ounces of potassium permanganate is usually sufficient. In a review of recent advances in Tropical Medicine there is an extract from the Union Pharmacuetique describing a method followed by

M. Celestion Hy based on a scheme devised by MM. Jerard and Bordes. The method is as follows :—The water to be purified is first treated with a powder consisting of one part of potassium permanganate to seven parts of sodium carbonate and slaked lime. After five minutes' interval eight parts of anhydrous ferrous sulphate are added. The method is based on the fact that potassium permanganate in alkaline solution oxidises organic matter and destroys micro-organisms. The sodium carbonate precipitates any bicarbonate of lime that may be present and the ferrous sulphate removes any excess of potassium permanganate present in the form of a dense precipitate.

The resultant water is pure and limpid and contains only a small amount of suplhate of K. and Na.

5. *Lime* is occasionally used in the strength of 1 oz. to 1 c. foot.

6. *Chloride of Lime.*—Experiments conducted at St. Maur shewed that when water in the proportion of 16 cubic metres was treated with 5 grammes of chloride of lime and 41 grammes of sulphate of alumina the turbidity was removed, the organic matter reduced, and the bacteria reduced from 62,770 per c. c. to 245 per c. c. The B. coli which in 400 c. c. numbered 8,000 were absent in the treated water except on one occasion.

7. *Bromine Solution.*—A mixture of bromine 20 parts, potassium bromide 20 parts, and water 100 grammes if added to about 67 litres of water is capable of killing all the Typhoid and Cholera bacilli that may be present. The bromine present is neutralised by an alkaline powder contained in corked tubes of 12 grammes each. These tubes contain sodium sulphite 7.2, anhydrous sodium carb. 3.0 and mannite 1.8 gramme. This quantity is supposed to neutralise the quantity of bromine generated by the previous process.

8. *Sodium Bisulphate.*—Rideal and Parkes suggest the use of sodium bisulphate in the proportion of 15 grains to one pint. It causes a somewhat acid taste in the water but Cholera vibrios and the Enteric and Dysentery bacilli are killed by ½ hour's contact.

Notter and Firth have devised a tabloid containing 2 grammes of 70 per cent. bisulphate sweetened with saccharine and flavoured with oil of lemon. One tabloid for every 1¾ pints of water sterilises the water in 20 minutes.

9. *Chlorine.*—Wilcox, discussing Nesfield's process of disinfecting water by chlorine, states that experiments were made on B. coli and Typhoid and Shiga's baccillus of Dysentery. Nesfield found that, after pouring 10 c.c. of a 24, 48, and 64 hours old broth culture into one litre of tap water, in 5 minutes this water was sterilised by 0.125 gramme of chlorine. The water was subsequently dechlorinated by sodium sulphite, the action being illustrated in the formula below :—$Cl_2 + H_2O + Na_2SO_3 = NaSO_4 + 2HCl$. The chlorine was at first obtained from liquid chlorine gas in lead lined cylinders, subsequently Nesfield devised a tablet of the following composition :—1½ grains of bleaching powder mixed with ½ grain of sodium bicarbonate is sufficient to sterilise in 5 minutes a pint of water teeming with Typhoid and Cholera germs. At the expiration of this period, ¼ grain of sodium sulphite renders the water free from chlorine. The bicarbonate of soda is added to the tablet to keep it dry and to assist in liberating chlorine from the bleaching powder. Windsor working with chlorine found that 1 in 350,000 was sufficient to kill Typhoid and Cholera microbes introduced into Agra tap water, but working with well water he found 1 in 250,000 was necessary, due probably to the amount of albuminoid matter present in the well water. In these dilutions, after the well had stood for 15 hours, no taste of chlorine could be detected.

Experiments by other observers have not been uniformly successful.

10. *Calcium Hypochlorite.*—Thresh experimenting with chalk water, rain water, tap and well water and using Typhoid and coli communis bacilli found that very minute quantities sufficed for sterilisation. In most cases 1 part of chlorine as hypochlorite to 1 million of water was sufficient in a few minutes. By adding sodium bisulphite the remaining portion of chlorine is removed and the palatability of the water is not impaired. In every experiment the available amount of chlo-

rine was estimated. In earlier experiments some failures occurred, due to the fact that the organic matter added had absorbed all the available chlorine leaving none to act on the bacteria. The quantity of chlorine destroyed by water appears to be a good index of its quality.

Quantities to be used :—Calcium hypochlorite (containing 33 per cent. of available chlorine) to be used in the proportion of about 0·02 gramme per litre. About ¼th of that amount of sodium bisulphite is required. Waters containing organic matter, such as peaty moorland waters, require more chlorine. The hypochlorite is added as the water enters the tank and the sodium bisulphite as it enters the storage or service reservoirs. Failing sodium bisulphite, the residual chlorine can be removed by a thin layer of iron filings on top of sand or by aluminium, but a layer 12 inches in thickness is required. Polarite will also remove it.

11. *Sodium Hypochlorite* in the proportion of 70 grains per 100 gallons has been successfully used. The sodium hypochlorite should contain at least 12% of free or available chlorine.

12. *Iodine.*—Vellard's red, white and blue tablets form a valuable method of rendering water safe in districts, where no other form of protection is available. The red tablet consists of tartaric acid, the white of sodium hyposulphite and the blue of potassium and sodium iodide. Method of use :— For one litre of water dissolve one red and one blue tablet in 2 or 3 tablespoons of cold water and add this solution to the litre of water, shake and mix well. The water becomes yellow due to free iodine. After 10 minutes add one white tablet when, as a result, the water becomes colourless, due to the formation of iodide. The amount of iodine liberated in the above process is 60 m.m. and iodine in the strength of 25 m.m. per litre of water will kill with certainty the bacillus of Typhoid, the B. coli communis and the Cholera vibrio in from 5 to 10 minutes.

13. *Nesfield's Method.*—Windsor experimenting added one 2 grain tablet of mixed iodide and iodate of sodium, and one 2 grain tablet of citric acid to four gallons of sterile water

and introduced Typhoid and Cholera germs and arrived at the conclusion that these tablets when introduced as above kill, in one minute, all Typhoid and Cholera germs when present in numbers above 50,000 per c. c. The addition of similar tablets to one pint of water will kill B. subtilis and B. anthrax when present in numbers over 2,000 and 500 respectively in 5 minutes and is fatal to ordinary pathogenic bacteria.

14. *Ozone.*—Ozone is prepared by the silent discharge of high tension electricity through perfectly dry air. The air drawn into the ozone producer is first of all dried by the use of calcium chloride or by refrigeration. There are various patented processes of applying the ozone to the water, the general principle running through all being that the water under pressure is sprayed into an atmosphere of ozonized air and then passes through towers filled with smooth stones to give further contact and mixture with ozonized air.

Experimentally, it has been claimed that as a result of this treatment the water is rendered clear and colourless, that the organic matter as measured by potassium permanganate is reduced, that any bad taste in the water is removed and that no peroxide of hydrogen is afterwards found. Any sulphates, carbonates and chlorides present are unaffected while nitrates of free oxygen are increased. It also effects a reduction in the number of organisms present, including B. coli communis.

On the other hand, it has been alleged that among the disadvantages of ozone treatment are:—the disagreeable taste imparted to the water which can only be got rid of by allowing the water to stand for some time; the difficulty of producing ozone without at the same time producing nitrous acid; the first cost and cost of maintenance and supervision are high, the water to be treated must first be filtered or stored to remove suspended matters; the difficulties of dosage, and the impossibility of establishing a control showing at each instant the efficacy of the treatment.

Sterilisation of Water by the Ultra Violet Rays.

The physicist has long known the ultra violet rays and has produced them in his laboratory by different methods, principally, the carbon bisulphide lamp, or the arc between metal electrodes, a method used by Finsen for the treatment of Lupus and other diseases. These sources of ultra violet rays are complicated, however, and the quartz mercury vapour lamp is probably the first really convenient source of the rays which are produced between metal electrodes, mercury being the metal used.

The sterilisation of water by means of these rays is not a chemical process.

Nogier in conjunction with M. Thevenot and M. J. Courmont made researches in the power of the ultra violet rays emitted from a mercuric vapour electric lamp to sterilise drinking water. The earlier experiments showed that the rays have little penetrative power in non-limpid waters and that the presence of colloidal matters practically nullified the action. Further experiments showed that water which contained 100,000 B. coli communis per c. c. was completely sterilised in one minute. A similar result followed double this dose of B. coli communis. A still worse mixture containing a million bacteria, 100,000 B. coli communis and 200,000 Eberth's bacilli was treated equally successfully. The water must be clear, so filtration (prior) is almost obligatory. Chemical reaction is not set up. The rays act essentially as bactericides. The water undergoes no appreciable alteration as regards taste, odour or appearance. M. Nogier has invented an economical solution to the commercial application of his discovery. His apparatus is simple in construction, easy to work, whether the amount of water be large or small, and it is cheap.

Special Treatment of Peaty Waters.—Very many peaty waters have a plumbo-solvent action and various devices have been adopted to overcome this difficulty. Previous reference has been made to this subject and the following is the method adopted in Paignton. The water-supply to this town comes from a moorland gathering ground on Dartmoor and, though otherwise of good quality, it had formerly, in common with more or less all moorland waters, a very solvent action on lead. In 1909 special filters were installed, and continuous tests since made show that the water is now non-plumbo-solvent and fit for dietetic purposes. The special filters first remove from the waters the peaty solids in suspension, and afterwards render it non-plumbo-solvent by passing it through a chamber containing magnesium oxide, a material which has, after exhaustive trials, been found to be the most reliable substance yet discovered for destroying the plumbo-solvency when used on the system of the Candy Filter Company of Westminster. Finally, the water is oxidised and purified by a layer of polarite (also contained within the filter) and then discharged into the clean water tank. Magnesium oxide, which is a hard granulated substance prepared by the Candy Filter Company, dissolves very slowly and in terms of hardness is more efficient than lime or chalk. The depth of the layer of magnesium oxide in the filter is in proportion to the acidity of the water and the filter is so arranged that, as the oxide is slowly taken up by the water, it can be replenished at intervals (once every week or two is sufficient) by a little more being added through a special charging door provided in the filter for such purpose. The filtered water was subjected to the usual chemical tests and showed free alkalinity with phenolphthalein as compared with free acid with the untreated water and 3 degrees of hardness in the treated water as compared with .6 in the water direct from the impounding reservoir, thus satisfactorily indicating that the soft character of a mineral water may still be retained and yet the water be rendered non-plumbo-solvent by passing through the Candy special filter. The system is extremely simple and a distinct advance on the usual chemical processes for the removal of plumbo-solvency as it entirely does away with the trouble, uncertainty and unreliability attendant upon the ordinary chemical mixing and gauging appliances, machinery, small pumps, etc., and it has the great advantage of combining in one filter three different processes, *viz.*, straining, rendering non-plumbo-solvent, and filtering and oxidising the water.

The Filtration of Water.

This must be considered from two points of view depending on whether the filtration is required on a large or a small scale.

The researches of Houston have shown that efficient storage and filtration are very intimately associated. The objects of filtration are to remove turbidity, taste and odours, to remove very fine suspended matter and to remove low forms of animal and vegetable life and bacteria and also to remove organic matter in solution. Filtration on the large scale may be by the more usual slow sand process or by the method so frequently seen in America—by the agency of mechanical filters. Sand is the most usual filtering medium and many experiments have been carried out to determine the best conditions under which such filters should work.

Frankland, working at the London Filters in 1885, came to the conclusion that storage of water prior to filtration should be considerable to allow of sedimentation and the filtration should not exceed a certain rate and that the depth of sand should be considerable and the filtering materials be renewed frequently.

Depth of Sand:—The Massachusetts experiments of 1893 showed that with deep layers of sand increased rapidity of filtration caused a slightly larger proportion of bacteria to pass through the filter and that within certain limits the depth of sand exerted but little influence, except when the water was being filtered rapidly. With moderate rapidity, *e.g.*, 2,000,000 gallons per acre per day, one foot of sand appeared as effective as five. The German Board of Health has fixed 2 inches of sand as a minimum limit below which the sand must never be scraped.

Size of Sand:—In the Massachusetts experiments it was found that with both continuous and intermittent filtration the finer sands were more effective; further, that fine sand required more frequent scraping than coarse, whether the filtration be continuous or intermittent, (though filters used continuously require less frequent scraping than when used intermittently) and that shallow filters required more frequent scraping than deep owing to the smaller head available in the former.

Mr. Hagen in summing up a series of experiments says :—Both the quality of the effluent and the cost of filtration depend on the size of the sand grains. With a fine sand the sediment layer forms more quickly and the removal of bacteria is more complete, but, on the other hand, the filter clogs more quickly and the dirty sand is more difficult to wash and the expense is thereby increased. With very fine sands it is almost impossible to drive bacteria through and the filtrate is practically sterile but the rate is too slow. With a coarse sand the suspended matter including bacteria penetrates further and consequently thicker layers have to be removed. The minimum expense for cleansing will be secured with a sand which does not allow this deep penetration.

Thresh's specification for the effective size of sand is that the whole of the sand should be of such fineness that it will pass through a wire sieve having 400 meshes to the square inch, and 80 per cent. of it will pass through a sieve having 900 meshes to the square inch, and none of it through a sieve having 3,600 to the square inch.

Rate of Filtration :—Koch after many experiments came to the conclusion that the maximum rate of filtration should be fixed at 2,000,000 gallons per acre per day and that the filters should be tested every day.

Filtering Agent :—The real effective agent in removing organisms from the water undergoing filtration is the layer of slimy organic matter which forms on the surface and if this surface be removed by scraping, or its continuity be affected in any way, the number of bacteria which pass through increases. A similar layer is supposed to form about the particles of sand in the filter bed. Frost, water rich in vegetable growths, insects, eels, too great a rush of water, etc., may cause loss of continuity of this surface layer, which consists of diatoms, green and blue algæ, bacteria, desmids and animalcula.

Hazen states that in the winter it is chiefly of diatoms and in the spring green algæ appear, whereas blue algæ are more numerous in the hottest months continuing into autumn and disappearing in winter.

Certain experiments carried out showed that over 80 per cent. of the bacteria removed by a sand filter were found in the upper inch of sand and 55 per cent. in the upper ¼ inch.

Now, after a certain period of time, which varies according to circumstances, it is found that the output of a filter lessens considerably, in consequence of which it is necessary that it should be cleansed and scraped. This is done by scraping away a thin layer of sand from the top, the average depth required to be removed being ⅛—¼ inch, decreasing as the fineness of the sand increases. The effect of scraping the filter to remove the clogged surface layer is to permit an increased number of organisms to pass through; consequently, after scraping, water should be allowed to stand on the filter bed for about 24 hours and even then the first filtrate that passes through should be rejected. The object of this is to allow the filter bed to mature again. In the Massachusetts experiments, the effects of scraping were more marked in shallow filters and in filters where a high rate of filtration was maintained.

The frequency of scraping depends on the character of the raw water (sediment basins being essential to the successful treatment of turbid river waters), on the thoroughness of the preliminary precipitation, the size of the sand grains, the rate of filtration and the maximum loss of head allowed. Covered filters are an advantage, as in the comparative darkness there is less tendency to the growth of algæ on the filters in summer; consequently, the frequency of scraping is somewhat reduced. At Zurich, where both covered and uncovered filters are in use, the periods between scraping average longer in the former. With suitable conditions the periods should never be less than one week, and but rarely exceed two months.

In most European cities the depth of water on the filters varies between 36 and 52 inches. Each filter bed should have a separate contrivance to regulate the pace of filtration, each bed should be small, never exceeding one acre in extent, and it is most desirable that all filter beds should have separate filter wells for sampling purposes in order to see that the bed is working satisfactorily. It is not sufficient that the quality of the mixed filtered water is good; each of the units filtering should be in proven and perfect working order. The total area of filter beds required in any case is calculated from the quantity of water required for all purposes, the rate of filtration, plus an allowance for filters out of use for purposes of cleaning. In many places filters after cleansing are filled up from below, the water being introduced through the under drains.

Besides removing bacteria, sand filters also remove and oxidise any ammonia and nitrites present. The disadvantages of sand filters are the slow rate of filtration, the cost of cleansing, and the loss of time before the water from a recently cleansed filter can be passed into the pure water supply.

Sand Washing.—In London and Antwerp the sand is washed, on an inclined plane surrounded by a wall, by means of a hose. The sand is kept to the upper part of the plane while the water and dirt flow off. In Germany it is washed in a revolving cylinder.

In Bombay City it is washed in pits provided with perforated false bottoms through which water is introduced. The sand is agitated by workmen standing in the pits. After prolonged washing the sand is removed and exposed to the action of the sun for a period of time.

Influence of Storage of Water prior to Filtration.

The recent researches of Dr. Houston, Director of Water Examinations, Metropolitan Water Board, have demonstrated the great value of storage prior to filtration. In his third report to the Metropolitan Water Board, Dr. Houston states that adequately stored water is probably incapable of causing epidemic disease. He does not advocate supercession of filtration but rather storage plus filtration, and in support of this view he advances what is termed the triple plea in favour of the safety of stored river water.

(*a*) The microbes of water-borne disease rapidly perish in river water under storage, so far as this may be judged by the result of artificial laboratory experiments with the

Typhoid bacillus and the Cholera vibrio. (99 per cent. of both these organisms die within one week under storage in the laboratory.)

(*b*) The microbes of water-borne disease are probably never present in raw river water in like number with B. coli communis.

(*c*) The marked reduction in the number of B. coli, when raw river water is stored for a sufficiently long period, affords a fair basis for inferring a still more marked reduction (if not a total elimination) of the less hardy and less numerous organisms of water-borne disease.

Under laboratory conditions of experiment Dr. Houston shows that, on the average, 10 days was sufficient for the B. coli to disappear from 10 c.c. of raw Thames and Lee water. Ten days would suffice for the destruction of the vast majority of Typhoid bacilli even if these were artificially added to river water in enormous numbers. The chief points advanced by Dr. Houston in favour of the storage of raw river water prior to filtration are :—

1. Storage reduces the number of bacteria of all sorts, and the number of bacteria capable of growing on agar and bile salt medium at blood heat, chiefly excremental bacteria. 2. Storage reduces the number of typical coli Bacilli and coli like microbes. 3. It alters certain bacteriological water ratios, *e.g.*, it reduces the number of typical B. coli to a comparatively greater extent than the number of bacilli of all sorts. 4. If sufficiently prolonged, it devitalises the microbes of water-borne diseases, *e.g.*, Typhoid and Cholera. 5. It reduces the amount of suspended matter, colour, and ammoniacal nitrogen. 6. The amount of oxygen absorbed from permanganate is reduced, as is usually the hardness also.

Storage tends generally to lengthen the life of the filters and the use of adequately stored waters renders any accidental break-down of the filters much less serious than might otherwise be the case. The results of storing water are such as to justify the policy of storing all river water before filtration. As to the question of the exact number of days water should be stored before filtration, Dr. Houston expresses the opinion that raw river water should be stored antecedent to filtration preferably for 30 days.

In his sixth report Houston remarks "even putting sedi-"mentation and devitalisation completely on one side, the "levelling effect of storage renders the possibility of any "sudden, accidental, concentrated and dangerous pollution "of the river water above the intakes a matter of much "less concern than would otherwise be the case.

"Storage in this sense is equivalent to dilution inasmuch "as it spreads the poison over weeks or months and it may, "indeed, quite apart from any question of devitalisation, "render innocuous a microbial contamination, which in a "concentrated form would be apt to be dangerous."

These three factors of sedimentation, devitalisation and equalisation are of supreme importance in connection with the storage of impure river water antecedent to its filtration.

Domestic Filtration.

There are two systems of domestic filtration, *viz.*, the low and the high pressure system. In the latter the filter is directly attached to the water pipe and the pressure is derived from the main. In the former the pressure is merely that derived from the water lying on the filter bed.

The best high pressure filters are the Pasteur-Chamberland and the Berkefeld.

The Pasteur-Chamberland consists of a candle or cylinder of fine grained unglazed porcelain enclosed in a metal jacket. The cylinder is closed above and terminates below in a nozzle. Between it and the metal jacket there is a space both above and on all sides. The water under pressure from the main enters the metal jacket and circulates round the cylinder and passes from without into the interior of the candle to be delivered *via* the nozzle as purified water. The rate of filtration depends on the pressure.

The Berkefeld is somewhat similar in design. It is composed of compressed infusorial earth. It is thicker but at the same time more porous and much more liable to fracture than the Pasteur-Chamberland.

After prolonged use the filtering capacity of both types becomes much lessened and the filtrate ceases to be so good in quality. The former is due to the clogging of the filter by suspended matters arrested on the surface and the latter to organisms growing through the filter.

The cylinders should be periodically cleansed by brushing them in hot water and subsequently sterilising them by steam or in the flame of a Bunsen burner or large spirit lamp.

Clarification of the water prior to filtration greatly prolongs the life of the candles.

It should, perhaps, be unnecessary to state that the development of the slightest crack in the candles renders them useless as filters ; yet one often sees cracked candles in use. This point should always be carefully attended to and one must always remember that the candles require careful handling.

Slow Filtration without pressure from the main.

Of recent years the Berkefeld and other companies have placed such filters on the market. They require most careful attention to cleanliness and the preliminary use of coagulants if the water is at all muddy.

Many old patterns of filters are still sold, all more or less useless and some indeed a source of positive danger, *e.g.*, the charcoal filter, which oxidises organic matter but does not sterilise the water but rather favours the growth of bacteria by adding nitrates to the water as well as phosphates, both of which act as nutrient media. It attacks putrifactive organic matter but allows fresh to pass. Polarite, magnetic carbide and spongy iron have all been used.

Rapid Filtration by Mechanical Filters.

Many mechanical filters have been introduced from time to time. The general principle of all is that water is introduced into a tank containing a filtering medium and passes through at a rapid rate. Where turbid rain waters are treated, alum is added to clarify the water before it passes through the filter.

Aitkin's Filter consists of a perforated metal cylinder containing sand arranged in a tank so as to revolve easily on turning a handle. The cylinder is only partially filled with sand and the clear water collecting tubes lie as near as possible to the centre of the filtering material as it lies in the cylinder.

Morrison's Filter consists of a tank, a bed of sand and a rake or agitator. Alum is added to form a coagulum quickly. To clean it the rake and current of water are reversed. If the water is very soft, a little calcium carbonate is added for the alum to act upon. This filter gives 120,000,000 gallons per acre per day.

The Jewell Filter consists of a tank containing sand of great uniformity, resting upon a suitable screen carrying a series of radiating pipes with nozzles for collecting the water. The thickness of the sand is 4feet. The rate of filtration varies from 1,600 to 3,200 gallons per square foot per day, *i.e.*, 70 to 140 million gallons per acre. The head of water to maintain this rate is 6 to 14 feet. The upper three inches of the sand is found to strain out most of the suspended matter and, when this upper surface becomes too clogged for filtration to be economically continued, the sand bed is washed by reversing the flow, using filtered water. Occasionally, a little caustic soda is added to further cleanse the sand and steam is blown in. To obtain uniform results it is necessary to gradually increase the pressure as the porosity of the sand decreases. It is claimed that these filters only occupy a small area of ground, that they are easily and rapidly cleaned, and that objectionable growths cannot take place in the filter and there is less risk therefore of the water acquiring odour or taste. The sand can be easily sterilised if required.

The Candy Filter is a filter in which sand and polarite (a magnetic oxide of iron) form the filtering medium. A closed tank is divided into compartments containing polarite and sand. The unfiltered water enters under slight pressure and in doing so is sprayed so as to become charged with compressed air. Each compartment of the cylinder is a separate filter. A considerable portion of the organic matter is oxidised and bacteria are removed. By occasionally reversing the current, the suspended dirt which has been stopped by the filter is removed. The filter is successful in removing iron and lead from waters.

Bischof's Spongy Iron is iron which has been reduced from the ore without undergoing complete fusion. It was first used on a large scale at Antwerp to purify the water from the Nethe.

This water is filtered through a bed consisting of a layer of spongy iron and gravel 3 feet thick overlaid by two feet of sand. The filtrate is subsequently filtered through sand to deprive it of ferric oxide and thence passed to clear water tanks. Experience showed that, besides a deposit on the surface, a second deposit took place in the iron layer of the bed. These deposits clogged the filter. To overcome this difficulty—

Anderson's Revolving Filter was introduced. It consists of a hollow revolving cylinder, inside which are 5 shelves. Iron in a finely divided state is introduced into the cylinder and by means of the curved shelves it is carried to the top of the cylinder and thence is showered down through the water. Various sizes are made. One 20 feet long by 5 in diameter, requiring less than one horse-power to drive it, treats 1,000,000 gallons per 24 hours allowing the water to be in contact with iron 3½ minutes. If the water is very foul 5 minutes or more contact can be given by means of a sluice valve on the inlet pipe, which controls the rate of flow through the cylinder. The water leaves the purifier charged with protosalts of iron and is aerated by flowing over weirs or by forcing air through it. The ferrous salts by this means become oxidised, the carbonic acid escapes and the resulting ferric oxide is removed either by precipitation in settling tanks and subsequent filtration through sand at the rate of one foot vertically per hour, or by the latter process alone.

Spencer's Magnetic Carbide is magnetic oxide of iron in combination with carbon. It is prepared by roasting hæmatite iron ore with granulated charcoal at a dull red heat for 12 to 16 hours. In filters it is used in layers between 3 and 12 inches thick, according to the degree of impurity of the water, the grosser matter in suspension being filtered out by a twelve inch layer of sand above the magnetic carbide. This method of filtration is used at Wakefield in treating the Calder water.

Examination of Water.

A few remarks may be made on the object, etc., of water examinations. In the first place the analysis may be either chemical or bacteriological or both, and, it may be here stated, that while the adoption of the former method alone may enable the analyst to at once condemn a given sample of water as unfit for human consumption, the converse is not true. It is now recognised as essential to conduct a bacteriological examination as well before definitely deciding that a sample is fit for internal use. The objects of a chemical examination are to ascertain whether a sample of water contains any substances, either dissolved or suspended, which are likely to do harm, or which, though perhaps harmless in themselves, are indicators of a possible previous contamination of the water, either remote or recent. The results must be examined from the qualitative and quantitative point of view, and also due weight must be attached to the physical and microscopical appearance of the water.

Although it is not desirable to enter into the technique of the various methods of testing water both chemically and bacteriologically, reference may be made to one or two points which may assist in correctly appraising the significance of the various analytical data adduced in the laboratory.

Collection of Samples for Examination.

The collection of samples for chemical and bacteriological examination requires very great care if the results are to be relied upon.

For chemical examination, the water may be collected in a Winchester quart bottle which has been thoroughly cleansed and sterilised. The bottle should be closed with a stopper of glass and not by a cork.

If for bacteriological examination, it is best to use a Pasteur's bulb which consists of a glass tube blown out at one end to a bulb and drawn out at the other end to a fine point. These bulbs are supplied perfectly sterile. They contain a partial vacuum and when about to be used they are held under water and the thin sealed drawn-out end is broken off, thus allowing the water to enter the tube. When the specimen has been obtained, the drawn-out end is again sealed by means of a spirit lamp and the bulb is replaced in the special metal case provided.

When taking a specimen from a hydrant, tap or pump, the water may be allowed to run for some time before collecting the sample, unless the object of analysis is to test for the presence of lead, iron, etc.

If the sample is from a reservoir, then it should always be taken from the windward side and from not too near the bank as the sediment there may contain many organisms. The bulb should be held well away from the bank by means of a rod, and it will be quite easy to fix up an arrangement to enable the sampler to break off the fine drawn-out end. If taking a sample from a well, use a perfectly sterile weighted bottle. Having obtained a sample, from whatever source, it is most important that no time be wasted and that the sample packed in ice be at once despatched to the analyst. The ice is to prevent undue multiplication of the organisms present.

Any delay in forwarding the sample may entirely vitiate the analysis and give an erroneous impression of the quality of the water.

It is most important that the whole operation should be conducted in such a manner as to exclude any possible extraneous contamination.

In the event of a supply of water becoming polluted, it may be necessary to examine the whole of the collecting ground in order to ascertain the source thereof. To do this one must follow up each stream feeding the reservoir to the spring or moorland surface from which it is derived and apply the following test to each stream in succession. Obtain a sample at the source and also just at its entry into the reservoir and examine both bacteriologically and chemically : if the latter sample is found to be more impure and to contain organisms indicating sewage contamination, then follow up the stream and note all contributory streamlets and take samples just above and below the point of entrance of all such. In this manner one may ascertain the source of contamination.

Minute enquiry must also be made into any history of illness of any of the employés and others who may have occasion to frequent the gathering ground.

Inspection must also be made to ascertain the presence or otherwise of small villages or isolated houses on the catchment area. If such be found, one must ascertain the method of conservancy adopted and where the liquid refuse matter is disposed of. Most frequently it is the nearest stream, where also washing of cloths, &c., is carried out. This should be ascertained and samples taken from this stream and also from the lake or reservoir close to the point of entrance of the stream. One should also ascertain the kind and number of the animals kept by the villagers.

One cannot dogmatically state what should be the composition of a good drinking water or give an absolute value to the significance of any one analytical datum. The analysis must be considered as a whole and in relation to the source of the water.

The chlorine in a water is nearly all in the form of sodium chloride. An average of a series of examinations in England is as follows :—

Rain water contains ·22 per 100,000, upland surface 1·10 per 100,000, spring water 2·5 and deep well water 5·0 per 100,000.

Sources of the chlorides :—Rain water, especially that falling near the sea-coast, often contains chlorides. Certain geological formations may contain strata bearing chloride of calcium and soda. Alkali works and mines may contribute some, wells near the sea are often brackish, and finally they may be present as the result of admixture with liquid excreta of men and animals, as urine contains about 1% of chlorides. In considering, therefore, the significance of chlorides, these possible sources must be borne in mind. If they come from strata containing sodium and calcium chloride, the water may be found alkaline from the presence of sodium carbonate, the oxidised organic matter may be absent or nearly so and often there is much sulphuric acid. The characteristics are common in deep well water. The amount present may vary considerably according to the strata, and it is necessary to know the amount normally present for such district, and any variation from this would indicate the need for a further investigation. When due to admixture with sea water, much magnesia and but little evidence of oxidised organic matter may be found; examples of such are sometimes seen in wells sunk near the sea shore or tidal rivers. When present, due to recent contamination with sewage, they will generally be present in marked quantity but not necessarily so. And there will probably be evidence of nitric and nitrous acids and ammonia and sometimes of phosphoric acid, and, if the contamination be recent, of oxidisable organic matter. A stream fouled by sewage may show different amounts of chlorine at different periods of the day. As a general rule, contamination of a water with sewage can never take place without increase of chlorides, unless it be by some gaseous emanations, or unless the normal amount of chlorides in that particular geological formation is very high, in which case admixture with contaminated surface water or sewage may cause an actual decrease in the percentage of chlorides present. It must also be remembered that the presence of chlorides does not necessarily signify present pollution: the organic matter originally associated with them may have been completely oxidised and destroyed. Most good waters contain only 2 to 3 grains per gallon of common salt, and Wanklyn is of opinion that when 5 to 10 grains per gallon are present there is reason to become suspicious. Thresh is of the opinion that more than 50 grains of salt per gallon is objectionable and that 70 grains should condemn it absolutely.

Nitrogen in Water.

The nitrogen present may be in the form of free nitrogen, ammonia, nitrites, or nitrates or as organic matter.

Nitrites and Nitrates.

Nitrogenous organic matter undergoing putrefaction produces ammonia, and this is oxidised into nitrous and nitric acids by organisms in the soil. These acids unite with the lime, soda, and potash present, displacing the carbonic acid. Some geological strata contain a considerable proportion of nitrates, but a large proportion is by no means so common as in the case of chlorides. A water may be free from unaltered animal and vegetable contamination, but may contain oxidised products derived therefrom, either as the result of remote contamination, or due to oxidation which has occurred in the soil intervening between the source of contamination and the source of the water. The nitrates are the chief of these, but much care must be exercised in drawing conclusions from the amount of nitrates present. They may at times be derived from the soil, the contamination of which is very remote, and, on the other hand, in very bad waters the nitrates may be lessened as a result of the impurity, the organic matters present reducing these salts to a less oxidised form. Again the amount present may be reduced by the fact that growing crops take up ammonia, nitrites and nitrates, and further it must be remembered that animal matter, decomposing in the absence of air or of free oxygen, tends to destroy nitrates liberating nitrogen. The Rivers Pollution Committee found that animal organic matter produced much nitrites and nitrates and that vegetable matter produced but little, not being highly nitrogenous and decomposing but slowly. The coincidence of easily oxidised organic matter, of ammonia, and of chlorine in some quantity would point towards contamination by animal organic matter. If the water shows the presence of nitrates, but of no nitrites, and of but very little ammonia, then either potassium, sodium or calcium nitrate is present, probably derived from soil impregnated with animal organic matter at some anterior date. Nitric acid is the ultimate state of the oxidisation of nitrogenous organic matter, and when present it is always the result of pollution of the water itself or of the stratum. The process of nitrification is due to organisms. In some soils, especially sands and gravels and in ferruginous soils, the process goes on very rapidly, and consequently one must never omit the test for nitrates as otherwise organic pollution may be overlooked.

Nitrites.

The presence of nitrites indicates the existence of organic matter undergoing a change. It may either be a stage in the oxidation of such matter, or a retrogression from nitric acid as a result of the latter having yielded up some of its oxygen. It is rare to find any of the higher forms of life in a water rich in nitrites, though bacteria may be abundant. The presence of nitrites in the water of shallow wells or rivers is always of grave significance. In deep wells nitrates may be reduced to nitrites, due to iron, salts or other innocuous constituents of the soil and, as Thresh points out, nitrites may also be formed from nitrates by metal, such as lead or iron, forming the tube of the pump or the lining at the well. The presence of nitrites is always suspicious of sewage contamination, except when it is known that the water is of peaty origin.

As a general rule, water ought not to contain more than 0.5 per 100,000 of nitric nitrogen and no trace of nitrites. The coincidence of easily oxidised organic matter, ammonia and chlorides would point to organic matter of animal origin, and if nitrites are present the contamination is probably of recent origin. The presence of high nitrates in the absence of nitrites and a low quantity only of organic matter does not necessarily mean that the water is injurious, as unpolluted sub-soil water may give this analysis.

Saline Ammonia.

The exact significance of this is difficult to briefly discuss; generally speaking, the ammonia found in river, spring and well water is derived from pollution by animal matter, but the mere presence of ammonia in a sample of water cannot be held to indicate contamination with either vegetable or animal organic matter. All rain waters nearly contain ammonia, the quantity being considerable near large towns and especially in the first portion of a downpour. Many deep wells also contain ammonia, which is generally held to result from the reduction of nitrates and nitrites by ferruginous soils.

Albuminoid Ammonia.

Albuminoid Ammonia does not exist as such in water, it is purely a laboratory product, the result of reducing the nitrogenous matter in the water by boiling with alkaline permanganate solution. Waters from deep wells do not as a rule yield much albuminoid ammonia. The presence of much albuminoid ammonia with but little free ammonia is supposed to indicate vegetable contamination, often peaty, especially if the chlorides, nitrates and nitrites are low. Peaty waters often give much albuminoid ammonia but give it slowly. The purest water supplies yield either no albuminoid ammonia, or more usually form a trace up to 0·002 grain per gallon. A water which is safe for drinking purposes will seldom yield more than 0·005 grain per gallon, but in certain instances this limit may be exceeded, *e.g.*, in upland surface waters of peaty origin, which in general are beyond the reach of zymotic contamination. When the stratum may be excluded as a source, the nitrogen as nitrates should not exceed 0·1 per 100,000 ; in other cases the total combined nitrogen, including free and albuminoid nitrogen, should not exceed 0·4 per 100,000.

Oxygen Absorbed.

The amount of oxygen required to oxidise the organic matter in safe waters will not in general exceed 0·1 gramme per gallon, though here again the limit may be exceeded by upland surface waters in which organic matter of an innocuous nature may exist. A good well water does not often absorb more than 0·001 gramme per 100,000. Certain other substances absorb oxygen, *e.g.*, iron salts, sulphurretted hydrogen and peaty upland waters. Slight variations in temperature, acidity and alkalinity influence the readiness with which the permanganate parts with its oxygen. Tidy considers that in the first fifteen minutes the more or less easily oxidised animal matters are oxidised, while the oxidation of the vegetable organic matter does not take place for four hours or so. The ease of oxidation is not a very reliable index of the real amount of pollution present. The water must be regarded as suspicious, if within 15 minutes the amount absorbed exceeds 0·1 per 100,000 and in four hours if it exceeds 0·3 per 100,000, in both cases deduction being made for any nitrites or iron salts present. The permanganate does not act upon any fatty substances—starch, sugar, gelatine, urea, hippuric acid or creatinine present.

Wanklyn is of opinion that if the chlorides exceed 5 to 10 grains per gallon there is reason for suspicion and enquiry. If free ammonia and chlorides exist, but no albuminoid ammonia, the water may pass, and the same may be said even if albuminoid ammonia is present in amounts approaching 0·002 but less than 0·005 per 100,000 ; but if there is much free ammonia and the albuminoid ammonia reaches 0·005 per 100,000, the water should be looked upon with suspicion. If free ammonia is absent, or present in very small amounts only, and the albuminoid ammonia is less than 0·01 per 100,000, one need not condemn the water, but in all cases where the albuminoid ammonia exceeds 0·01 per 100,000 the water should be condemned.

Bacteriological Examination.

The object of a bacteriological examination is to ascertain the presence or absence of any organisms and, if present, to determine their number and whether they belong to the class of micro-organisms which, though not of necessity hurtful to man, are yet indicative of animal contamination, or whether they belong to actual disease bearing organisms, *e.g.*, Cholera and Typhoid bacilli. The detection of these latter in a public water supply is a matter of some difficulty, and in many instances one has to rely on the evidence afforded by the presence of organisms usually associated with fæcal contamination, either human or animal. In reporting on a water analysis, the bacteriological and chemical results must be carefully considered in relation to one another.

As it is only under exceptional circumstances that zymotic poisons gain entry to a water supply, without associated decrease of chemical purity in general, it will be found that a water thoroughly pure chemically will also be found pure bacteriologically.

On the other hand, a supply which gives bad results on chemical analysis should be condemned as, if free from pathogenic organisms on any particular occasion, it must be held to be at least liable to contamination with these and must form a good medium for the growth and dissemination of bacteria. It is in the case of waters of intermediate purity that a bacteriological examination becomes of the greatest importance, as though the amount of contamination may be such as to produce only a small amount of chemical impurity, yet it may be sufficient to cause marked bacteriological impurity.

The detection of the latter class is somewhat difficult, and in most instances one must rely on the evidence afforded by the presence or absence of organisms usually associated with fæcal contamination, either human or animal.

In both chemical and bacteriological examinations, great assistance is afforded by a knowledge of the exact source of the water and for this reason it should be an invariable custom to give full details when sending a sample for examination.

The covering letter should state whether the water is from a well, river, lake, etc., and if from a well it should be stated whether the well is a deep one, whether properly constructed and protected, the distance away of the nearest source of possible pollution, *e.g.*, cesspools, privies, drains, etc., also how the water is raised from the well.

Similarly, any details likely to be of value in regard to samples other than from wells should be sent. Further, if any authentic records of former analyses exist they should be furnished, as information may be gleaned from them as to any departure from the apparent normal.

From time to time various numerical standards of the number of micro-organisms permissible to be present in water have been proposed, but for many reasons no hard and fast standard can be enunciated.

Mace in 1897 suggested the following scale :—

Very pure water : 0 to 10 bacteria, per cubic centimetre
Good water : 100 to 200 ,, ,, ,, ,,
Passable water : 200 to 500 ,, ,, ,, ,,
Bad water : 500 to 1000 ,, ,, ,, ,,

Koch, judging of the efficiency of water filters, suggested as a standard that filtration could not be regarded as satisfactory, if the number of micro-organisms exceeded 100 in each cubic centimetre of water.

Too much importance must not be attached to the mere number of organisms present, as the results for comparative purposes vary greatly according to the nature and reaction of the medium used and the temperature and duration of exposure. Moreover, the source of the water influences the deductions to be drawn from the number present.

As a standard of efficiency of a given filter, a numerical count possesses perhaps some importance, as any large and sudden increase in number would draw attention to the necessity for an enquiry as to the cause.

In the qualitative test the nature of the organisms present is determined and here also attempts have been made to establish standards ; and some observers consider that there should never be more than ten different species of organisms present in a good drinking water. But here again, however, the nature of the organisms present is of the greatest importance. The organisms usually considered as indicative of sewage contamination are the B. coli, B. enteritidis sporogenes, B. typhosus and the Cholera vibrio.

It is obvious that both the quantitative and qualitative examinations (chemical and bacteriological) will have much greater value when, as is probable in the future, local standards of water have been determined, as any departure will then call for close enquiry as to the cause.

Dr. Houston has laid down the following requirements, which must be conformed to by any microbe indicator suggested as an indicator of pollution of water:—

(1) It must be superabundant in excremental matters.

(2) It must be absent, or present only in comparatively small numbers, in water free from undesirable pollution.

(3) It must be a decadent microbe when divorced from the animal body.

Throughout his observations Dr. Houston has chosen the B. coli test as the indicator of water pollution. The typical B. coli recognised by him is one yielding gas in lactose cultures and indol in peptone water cultures, *i.e.*, Lactose and indol +·

Now B. coli conforms to all the requirements mentioned above :—

(1) Since at a low estimate there are 100,000 B. coli present per cubic centimetre of crude sewage, or 1,000,000 per gramme of human fæces.

(2) Of 1,331 samples of Kent deep well waters examined, 94% showed no B. coli in 100 c.c., and

(3) B. coli removed from the animal body and kept at 20° C either in sea water or tap water dies usually in from 3 to 9 days. The B. coli is a decadent microbe when divorced from the animal body; hence its presence in a water in any number probably points to fairly recent pollution.

The Bacillus coli test even alone is of great value, but a water supply should be finally judged on a summation of verdicts (geological, topographical, physical, bacteriological, and chemical). The B. coli test is a reliable and speedy method of judging the degree of efficiency of the particular water purification process under investigation, and, when a sterilisation treatment is in operation, the certified destruction of B. coli should afford absolute proof, practically speaking, of the devitalisation of all the microbes of epidemic water-borne disease. The B. coli test is a practical and delicate one for excremental filth, and may be taken as a reliable indicator in its positive aspects of possible danger, and in its negative aspects of the almost certain absence of the microbes associated with epidemic water-borne disease, and, generally speaking, as the one test which, above all others, is least excusable for a water analyst to omit.

While in its negative aspects the B. coli test is of very great value, one must remember that it cannot guarantee the absence of positive results in the future, nor does it eliminate the possibility of infection of the water by Typhoid bacilli without colon bacilli from the urine of a carrier case.

The positive aspects of the test require always to be interpreted in relation to topographical conditions.

Waters may be classified as first class when B. coli is absent from less quantities than 100 c. c., second class when absent from less than 10 c. c., third class when absent from less than 1 c. c., and fourth and succeeding classes on the same decimal basis, but one must remember that under certain conditions a water of the third class might be passed or one of the first class condemned.

The subject of the proper interpretation to be placed on the facts adduced from the examination of water is a very difficult one, requiring much experience and knowledge; more especially is this so in tropical and sub-tropical countries.

Clemesha has shown that most of the waters which have to be used in India are simply loaded with fæcal contamination and expresses the opinion that a great deal of the pollution of surface waters is caused by excrement of animals, mostly cattle and goats, whereas in England the pollution that is most common in rivers has its origin in sewage from large towns which we know to be derived from man, and he considers this a difficulty in the way of accepting standards applicable to England as being equally suitable for India.

To meet this difficulty he suggests that uniform methods of analysis be adopted and results published.

Unquestionably, if the results are to be comparable, some standard of uniformity of method of examination must be adopted and ultimately valuable local standards may be arrived at.

McConkey by using the two sugars saccharose and dulcit divides all lactose fermenting organisms into four groups :—

(1) Ferments neither saccharose nor dulcit
(2) Ferments dulcit but not saccharose.
(3) Ferments both saccharose and dulcit.
(4) Ferments saccharose but not dulcit.

Major Clemesha, however, recommends proceeding further and by the use of the fermentation of adonit, inulin, dulcit and saccharose, the voges and proskauers reaction, the indol reaction, the motility test and, when possible, the liquefaction of gelatin test, splitting up the group of fæcal bacilli and studying the individual species as far as possible ; and thus in time he anticipates that one may be able to assign a relative value as an indicator of pollution to each of these organisms.

As the results of a large series of experiments, Clemesha proposes tentative standards for the various kinds of waters, and in the course of his experiments he has compiled a list of organisms grouped in three classes according to their power to resist sunlight, but expresses the opinion that as evidence accumulates class II may have to be re-arranged.

In the classification adopted by him, the organisms high up in the list of each class are considered to be less resistent than those at the bottom so far as present experience goes.

Class I (least resistent).	Class II.	Class III.
Oxytocus perniciosus No. 10 ,, 39 ,, 69 ,, 70 Nos. 97 and 98 Coli communis. No. 35 ,, 36	No. 33 ,, 38 Pneumonia. No. 9 Neapolitanus. Lactis Ærogenes Coscoroba Acidi Lactici No. 6 ,, 100 ,, 101	No. 73 ,, 75 Grunthal or 7 or 8 Cloacæ.

Clemesha very rightly insists on the fact that his proposed standards are only tentative ones, and adds that no analyst in any country would ever venture to give a definite opinion without knowing a few elementary facts concerning the source from which the sample has been taken. Such questions as, whether the samples are drawn from lake, river, well or spring—the quantity and date of recent rainfall—the condition in the case of a river, whether in heavy flood or nearly dry—are matters of great importance to the bacteriologist, who has to pronounce an opinion on the subject. Consequently in the application of the method proposed, the question the analyst should always bear in mind is—what chances has this sample had of being exposed to sunlight? The more exposure it has had the more will the arguments involved in this method apply to the water, and the less it has had, the more guarded must be any expression of opinion. For lakes, tanks, ponds, storage reservoirs, settling tanks, etc., the method is applicable. The extent to which it applies to rivers must depend on the condition of the river itself. The extent to which it is applicable to wells, springs and underground waters generally is uncertain, and this forms a serious limitation to the utility of the method.

PROPOSED STANDARDS.

LAKE WATERS.

Good Lake Water should contain—

(1) less than 100 colonies per c.c. (on agar @ 37°C.);

(2) no lactose fermenters in 20 c.c.;

The following table is taken from Clemeshas "Study of the Bacteriology of Drinking Water Supplies in Tropical Climates."

Number.	—	Lactose.	Saccharose.	Dulcit.	Adonit.	Inulin.	P.&V. reaction.	Indol.	Motility.	Grams stain.	Gelatin.	Litmus milk.	Acidity in litmus whey.	Reduction of nitrates.	Inosit.
													PER CENT.		
1		+	—	—	+	—	—	+	+	—	—	+	...	+	—
2	B. Acidi lactici (Huppe)	+	—	—	+	—	—	+	—	—	—	+	23	+	—
3	B. Levans	+	—	—	—	+	+	—	+	—	+	+	14	+	—
4	B. Grunthal	—	—	—	—	—	—	+	+	—	—	+	20	+	—
	B. Sulcatus gasiformans	...	..	...	...	...	...	...	...	...	...	..	...	...	...
	B. Castellus	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	B. Vesiculosus	+	—	—	—	—	—	+	—	—	—	+	25	+	—
6		+	—	—	—	—	+	+	—	—	—	+	...	...	...
7		+	—	—	—	—	—	—	+	—	—	+	...	—	—
8	B. Coli mutabilis (Massini)	+	—	—	—	—	—	—	—	—	—	+	...	...	...
9		+	—	—	+	—	+	+	—	...	...	...	...	...	...
10		+	—	—	—	+	—	...	...	...	...	...	...	...	...
33		+	—	+	+	—	—	+	+	+	—	—	...	...	—
34	B. Coli communis	+	—	+	—	—	—	+	+	—	—	+	28	+	—
	B. Cavicidæ	+	...	...	...	...	...	...	...	...	...	...	...	...	...
35	B. Schæfferi	+	—	+	—	—	—	+	—	—	—	+	22	+	—
36		+	—	+	—	—	—	—	+	—	+	+	...	+	—
37		+	—	+	—	—	+	...	—	...	...	...	...	...	...

38		...	+	−	+	+	−	+	...	...	...	...	...	...	...	...
39		...	+	−	+	−	+	−	...	+	...	...	...	...	...	...
65	B. Oxytocus perniciosus	...	+	+	+	+	+	+	+	−	−	+	+	26	+	+
66		...	+	+	+	+	−	−	+	−	−	−	+	...	+	−
67		...	+	+	+	+	−	+	−	−	−	−	+	...	+	+
68	B. Rhinoscleroma Pneumoniæ	...	+	+	+	+	−	−	−	−	−	−	+	14	+	+
69		...	+	+	+	−	+	+	−	+	−	+	+	...	...	−
70		...	+	+	+	−	+	−	−	+	−	+	+	...	...	−
71		...	+	+	+	−	−	−	+	+	−	−	+	...	+	−
72	B. Neapolitanus	...	+	+	+	−	−	−	+	−	−	−	+	22	+	−
73		...	+	+	+	−	−	+	−	+	−	+	+	...	+	−
74		...	+	+	+	−	−	−	−	+	−	−	+	...	...	...
75		...	+	+	+	−	−	+	−	−	−	−	+	...	...	+
97		...	+	+	−	+	+	+	+	−	−	+	+	...	+	−
98		...	+	+	−	+	+	+	−	−	−	−	+	...	+	+
99		...	+	+	−	+	+	−	−	−	−	−	+	...	+	+
100		...	+	+	−	+	−	−	+	+	−	−	+	...	...	...
101		...	+	+	−	+	−	−	+	−	−	−	+	...	+	+
102		...	+	+	−	+	−	+	−	+	−	+	+	...	...	...
103	B. Lactis ærogenes	...	+	+	−	+	−	+	−	−	−	−	+	30	+	+
	B. Dysentericæ Vitulorum	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	B. Capsulatus (Pfeiffer)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
104	B. Gasiformans non-liquefaciens ...	...	+	+	−	+	−	+	−	−	−	−	+	12	+	−
105		...	+	+	−	−	+	+	−	+	−	+	+	...	...	−
106		...	+	+	−	−	−	−	+	+	−	−	+	...	...	−
107	B. Coscoroba	...	+	+	−	−	−	−	+	−	−	−	+	25	+	−
108	B. Cloacæ	...	+	+	−	−	−	+	−	+	−	+	+	20	+	−
109		...	+	+	−	−	−	−	−	+	−	−	+	...	...	−
110		...	+	+	−	−	+	−	...	...	...	...	...	...	...	...

(3) no organisms of class I in 50 c.c. ;

(4) the few fæcal organisms isolated should belong to class II and lactis ærogenes should be plentiful.

Fair or usable Lake Water—

(1) should not contain more than 200 organisms per c.c. (agar 37°C.) ;

(2) lactose fermenters should not be present in less than 5 c.c. ;

(3) no organisms of class I should be present in less than 20 c.c. ;

(4) lactis ærogenes should largely predominate.

A Lake Water is suspicious—

(1) if it contains more fæcal organisms than 1 in a c.c., even though these be confined to class III ; as this indicates that the lake is very low and conditions are suitable for the spread of cholera.

A Lake Water should be condemned—

(1) if it contains organisms of class I in a c.c. or less ;

(2) if fæcal organisms are present in the characteristic proportions seen in fresh fæces ;

(3) if lactis ærogenes are absent or scarce. It should be remembered that 48 hours will make an enormous difference in the purity of a lake-water.

WELL AND SPRING WATERS.

(1) A good water should contain no fæcal bacilli in 20 c.c ;

(2) no organisms of class I in 100 c.c ;

(3) total colonies under 50 per c.c.

River Waters.

Good river water should contain—

(1) not more than 100 colonies (on agar @ 37°C.) ;

(2) fæcal organisms not exceeding one in 10 c.c ;

(3) no organisms of class I in 50 c.c.

Any fæcal organisms present should belong to either class III or to the more resistent class II.

Fair or usable River Water should contain—

(1) not more than 300 colonies (on agar @ 37° C.) ;

(2) not more than 1 in 1 c.c. of fæcal organisms and no organisms of class I in less than 20 c.c.

The fæcal organisms present should consist mainly of mixtures of class III and class II and there should be a tendency for one class of organism to preponderate.

River Waters should be condemned—

(1) if total colonies are more than 800 (on agar 37°C.) ;

(2) if lactose fermenters are present in number of 10 to 100 per c. c. ;

(3) if organisms of class I exceed 1 in 5 c.c., or if the fæcal organisms isolated (class I being absent) are rich in varieties, such as occur in an emulsion of fæces.

Clemesha in his work (which should be consulted in original for all details) does not accept the definition applied by Houston, Savage and others to the term "Coli bacillus" ; but adopts that applied by MacConkey, Orr and others, who use the term "Bacillus coli communis" in reference to Escherichs organism only, calling all bacilli that differ from it in any "permanent" test different species, to which different names or numbers are applied.

THE PROTECTION OF WATER SUPPLIES.

When discussing reservoirs mention has already been made that one must protect the gathering ground of any reservoir, as far as possible. No cultivation of the land should be permitted, nor should any human habitations other than those necessary for the caretaker or workmen employed, and these must be constructed in such a situation and so drained as to make it impossible for the water supply to be contaminated from this source.

The area should be well wooded and, where possible, fenced off.

No mining or manufacturing operations should be permitted within the area.

In many countries to control a gathering ground in this manner is a very difficult, if not impossible task, but in India this objection has not quite the same weight.

In regard to wells the precautions to be adopted have been fully enumerated already.

When the water-supply of a town or village is taken from a river, certain precautions are necessary in addition to those mentioned: especially in India, where so many religious ceremonies are so closely associated with certain rivers, at which the village washing and personal ablutions also take place.

The river should be mapped out into 3 parts. The uppermost portion should be strictly reserved for drinking water and water for domestic purposes, *e. g.*, cooking, washing, cooking utensils, etc. The portion immediately below this, in the direction of the flood of the stream, should be reserved for personal ablutions and the third and lowest portion for washing clothes.

In the presence of an epidemic of Cholera or Typhoid, it may be necessary to take more active measures.

Frequently, the bathing is carried out in pools along the river's edge and as the bathers use the water to cleanse their mouths,—and even drink it,—these pools should be disinfected with potassium permanganate, as should also the pools in which the clothes are washed. Efforts should be made to instruct the bathers in the risks they run by swallowing the water. This can best be done by addressing senior men and enlisting their aid. Provision should be made also to supply pure, boiled and aerated water to the bathers by establishing small depôts, due observance being paid to religious prejudices, etc.

It is of the utmost importance that water pipes should be laid well away from drains and closets and that the pipes be laid as far as possible in straight lines, and that they be well supported in their course so as to prevent sagging and consequent risk of opening of joints.

All overflow pipes from cisterns must be made to discharge into the open air and not permitted to be connected to a drain.

No water closet should be directly supplied by a tap, a cistern must always intervene, as otherwise foul air and filth may possibly be drawn into the pipe.

Provisions of Bombay Act No. III, 1888, *as modified to May* 1st, 1912, *relating to Water Supply.*

CONSTRUCTION AND MAINTENANCE OF MUNICIPAL WATER WORKS.

261. For the purpose of providing the city with a supply of water, proper and sufficient for public and private purposes, the Commissioner, when authorized, by the Corporation in this behalf, may—

(*a*) construct and maintain water works, either within or without the city, and do any other necessary acts;

(*b*) purchase or take on lease any water-work or any water or right to store or to take and convey water, either within or without the city;

(*c*) enter into any arrangement with any person for a supply of water.

262. The Commissioner shall manage all water-works belonging to the Corporation, all of which water-works are in this Act referred to as "municipal water-works," and maintain the same in good repair and efficient condition, and shall cause all such alterations and extensions to be from time to time made in the said water-works as shall be necessary or expedient for improving the said works.

263. (1) The Commissioner, and any person appointed by Government under section 264 in this behalf may, for

the purpose of inspecting or repairing or executing any work in, upon or in connection with any municipal water-work, at all reasonable times—

(*a*) enter upon and pass through any land within or without the city, adjacent to or in the vicinity of such water-work, in whomsoever such land may vest ;

(*b*) convey into and through any such land all necessary materials, tools and implements.

(2) In the exercise of any power conferred by this section, as little damage as can shall be done, and compensation for any damage which may be done in the exercise of any of the said power shall be paid by the Commissioner, or, if any person appointed under section 264 by Government has caused the damage, by Government.

264. Any person appointed by Government in this behalf shall at all reasonable times have liberty to enter upon and inspect any municipal water-work.

265. The Commissioner shall have the same powers and be subject to the same restrictions for carrying, renewing and repairing water-mains, pipes and ducts within or without the city, as he has and is subject to under the provisions hereinbefore contained for carrying, renewing and repairing drains within the city.

266. The Commissioner shall cause fire-hydrants and all necessary works, machinery and assistance for supplying water in case of fire to be provided and maintained; and shall have painted or marked on the buildings and walls or in some other conspicuous manner, within the streets, words or marks near to such hydrants to denote the situation thereof, and shall cause a hydrant-key to be deposited at each place within the city where a municipal fire-engine is kept, and to do such other things for the purpose aforesaid as he shall deem expedient.

267. (1) Except with the sanction of the Corporation and, in the case of the Vehar water-works, of Govern-

ment, or for the purposes of section 262, under the authority of the Commissioner, no person shall

(*a*) erect any building for any purpose whatever within the limits of the water-shed of any lake or reservoir, from which a supply of water is derived for any municipal water-work;

(*b*) extend, alter or apply to any purpose different to that to which the same has been heretofore applied, any building already existing within the said limits;

(*c*) carry on, within the said limits, any operation of manufacture, trade or agriculture in any manner, or do any act whatsoever, whereby injury may arise to any such lake or reservoir or to any portion thereof, or whereby the water of any such lake, tank or reservoir may be fouled or rendered less wholesome.

(2) The limits of the water-shed of the Vehar lake shall, for the purposes of this section, be deemed to be the limits defined in a plan marked B authenticated by the signatures of the Governor and Members of Council, and deposited in the office of the Secretary to the Government of Bombay.

268. (1) Without the written permission of the Commissioner, no building, wall or other structure shall be newly erected, and no street or railway shall be constructed over any municipal water-main.

(2) If any building, wall or other structure be so erected, or any street or railway be so constructed, the Commissioner may, with the approval of the Standing Committee, cause the same to be removed or otherwise dealt with as to him shall appear fit, and the expenses thereby incurred shall be paid by the person offending.

Public Gratuitous Water-Supply.

269. (1) All existing public drinking-fountains, tanks, reservoirs, cisterns, pumps, wells, ducts and works

for the supply of water for the gratuitous use of the inhabitants of the city shall vest in the Corporation and be under the control of the Commissioner.

(2) The Commissioner may maintain the said works and provide them with water, and, when authorised by the Corporation in this behalf, may construct any other such works for supplying water for the gratuitous use of the inhabitants of the city:

(3) Provided that the water carried away by any of the inhabitants from any such work shall be taken only for his private use and not for sale, and shall not, except with the written permission of the Commissioner, be carried away in a cask, cart, pakhàl or masak.

(4) The Commissioner may temporarily, and with the approval of the Corporation permanently, close any of the said works, either entirely or partially.

(5) In case any such work is permanently closed, either entirely or partially, by the Commissioner, the site thereof, or of the portion thereof which is so closed, and the materials of the same may be disposed of as the property of the Corporation: provided that if any such work, which is permanently closed, either entirely or partially, was a gift to the public by some private person, the said site and materials or the proceeds of the sale thereof shall, unless by reason of their value being insignificant or for any other sufficient reason the Corporation think fit to otherwise direct, be applied to or towards some local work of public utility bearing the name of such person, or to or towards any such local work which shall be approved by the Corporation and by the heirs or any other representatives, if any, of the said person.

270. (1) The Commissioner may assign and set apart each of the said works and the water therein for use by the public for such purpose only as

he shall think fit, and shall cause to be indicated, by a notice affixed on a conspicuous spot on or near each such work, the purpose for which the same is so assigned and set apart.

(2) No person shall make use of any such work or of any water therein for any purpose other than the purpose for which the same has been so assigned or set apart.

Private Water-Supply.

271. (1) Communication-pipes for conveying to any premises a private supply of water from a water-main or other municipal water-work shall not ordinarily be connected with the main or other water-work, except on the written application or with the written assent of the owner of the premises, or of the person primarily liable for the payment of property-taxes on the said premises.

(2) But if it shall appear to the Commissioner that any premises, situate within any portion of the city in which a public notice has been given by the Commissioner under clause (*b*) of section 141, are without a proper supply of pure water, the Commissioner shall, by written notice, require the owner of the said premises, or any person primarily liable for the payment of property-taxes thereon, to obtain a supply from a municipal water-work adequate to the requirements of the persons usually occupying or employed upon the said premises, and to provide communication-pipes and do all such works as may be necessary for that purpose.

[*Section* 141 (*b*) *reads as follows* :—

Subject to the provisions of section 169, the water-tax shall be levied only in respect of premises which are situated in a portion of the city in which the Commissioner has given public notice that sufficient water is available from municipal water-works for furnishing a reasonable supply to all the premises in the said portion.]

272. (1) No connection with any municipal water-work shall be made or renewed—

(*a*) except by a municipal officer or servant empowered in that behalf by the Commissioner, and

(*b*) until the certificate specified in sub-section (4) has been given.

(2) In every case where a new connection with a municipal water-work is made or an existing connection requires renewal, all necessary communication-pipes and fittings, from and including the ferrule on the supply main up to and including the stop cock nearest the supply main, shall be supplied by the Commissioner, and the work of laying and applying such communication-pipes and fittings shall be executed by municipal agency under the Commissioner's orders, but the cost of making or removing any such connection, and of all the communication-pipes and fittings so supplied, and of all the work so executed, shall be paid by the person on whose application or for whose premises the connection is made or renewed.

(3) Every such new connection or renewed connection with its communication-pipes and fittings up to and including its stop-cock as aforesaid shall thereafter vest in the Corporation and be maintained at the charge of the Municipal Fund as a municipal water-work.

(4) All communication-pipes and fittings beyond the said stop-cock shall be laid and applied under the supervision of a municipal officer appointed by the Commissioner in that behalf, who shall give and sign a certificate, free of charge, when such communication-pipes and all necessary fittings and work have been laid, applied and executed in a satisfactory manner and when proper and sufficient arrangements have been made for draining off waste water.

(5) Where any communication-pipe or fitting is laid, applied, added to or altered, or any connection is made in contravention of this section, the Commissioner may, with the previous approval of the Standing Committee, remove such communication-pipe, fitting or connection, and make good such water-work ; and the expenses incurred by him in so doing shall be paid by the owner or occupier of the premises in which or for supply to which such communication-pipe or fitting has been laid, applied, added to or altered, or such connection has been made, or by the person offending.

273. The Commissioner may, if he thinks fit, take charge on behalf of the Corporation of all communication-pipes and fittings of any existing private service connected with any municipal water work up to and including the stop-cock nearest the supply-main for the said service, and the same shall thereafter vest in, and be maintained at the expense of, the Corporation as a municipal water-work.

273A. The Commissioner may, if at any time he deems it expedient to alter the position of an existing connection with any municipal water-work, or of the communication-pipes or fittings thereof, and after giving to the owner of such communication-pipes or fittings not less than four days' previous notice of his intention so to do, cause the said connection to be moved to such other position as he thinks fit, and cause any or all of the said communication-pipes and fittings to be relaid and applied, or others to be laid and applied, in lieu thereof, in such position as he may direct ; and in every such case such removal and alteration shall be carried out at the expense of the Municipal Fund, and the new connection, with its communication-pipes and fittings up to and including the stop-cock nearest the supply main, shall thereafter vest in the Corporation and be maintained at the charge of the Municipal Fund as a municipal water-work.

274. (1) The Commissioner may, whenever it shall appear to him to be necessary, by written notice require that any premises furnished with a private water-supply from any municipal water-work shall within a reasonable period which shall be prescribed in the said notice, be provided with a storage cistern of such size, material, quality and description, and with such fittings and placed in such position as he thinks fit.

(2) The Commissioner shall also from time to time prescribe the size, material, quality, description and position of the pipes, taps, cocks and other fittings to be employed for the purposes of any connection with, or of any communication from any municipal water-work and no such connection or communication shall be made by any person otherwise than so prescribed.

275. It shall be incumbent on the owner or occupier of any premises to which a private water-supply is furnished from any municipal water-work, to keep in efficient repair every pipe conveying water from the said water-work to such premises and every meter for measuring water, not being a municipal meter, and every tap, cock or other fitting and every storage cistern in or connected with any such pipe, so as effectually to prevent the water from running to waste.

276. (1) Where water is supplied by measurement, the Commissioner may either provide a meter and charge the consumer for the same such rent as shall from time to time be prescribed in this behalf by the Standing Committee, or may permit the consumer to provide a meter of his own of such size, material and description as the Commissioner shall approve for this purpose.

(2) The Commissioner shall at all times keep all meters and other instruments for measuring water, let by him for hire to any person, in proper order for correctly registering the supply of water, and in default of his so doing such person shall not be liable to pay rent for the same during such time as such default continues.

277. Where water is supplied by measurement, the register of the meter or other instrument for measuring water shall be *primâ facie* evidence of the quantity consumed.

Inspection.

278. (1) The Commissioner may make an inspection of any premises to which a private water-supply is furnished by the Corporation, in order—

(*a*) to remove, test, examine and replace any meter for measuring water; or

(*b*) to examine the communication-pipes and the taps, cocks and other fittings thereof, and the storage-cisterns connected therewith; or

(*c*) to see if there be any waste or misuse of the water.

(2) The Commissioner may, by written notice, require the owner or occupier of the premises to remedy any defect which shall be found to exist in any such meter let to him for hire, or in any such communication-pipe, tap, cock or other fitting or cistern.

Cutting off Private Water-Supply.

279. (1) The Commissioner may, with the sanction of the Standing Committee, cut off any connection between any municipal water-work and any premises, to which a private water-supply is furnished by the Corporation or turn off the water from such premises in any of the following cases, namely:—

(*a*) in default of payment of any instalment of water-tax or of any sum due for water within fifteen days after the bill for such tax or sum has been duly presented ;

(*b*) if the owner or occupier of the premises neglects within the period prescribed in this behalf in any notice given under sub-section (1) of section 274, to comply with any requisition made to him by the Commissioner regarding the provision of a storage-cistern ;

(*c*) if the owner or occupier of the premises fails, within the period prescribed in this behalf in any notice given under sub-section (2) of section 278 to put any such cistern or pipe conveying water from any municipal water-work or any tap, cock or other fitting thereof into good repair so as effectually to prevent the water from running to waste ;

(*d*) if, after receipt of a written notice from the Commissioner requiring him to refrain from so doing, the owner or occupier of the premises continues (i) to use the water, or permit the same to be used, in contravention of any bye-law made under this Act or of any condition prescribed under sub-section (2) of section 169 ;

[*Sub-section* (2) *of Section* 169 *reads*—

The Standing Committee may, for the cases in which the Commissioner charges for water by measurement under clause (*a*), from time to time prescribe such conditions as they shall think fit as to the use of the water and as to the charge to be paid for water consumed whilst a meter is out of order or under repair ; and in each case in which a composition is made under clause (*b*), the said Committee may prescribe such conditions as to the use of the water as they shall think fit : provided that no condition prescribed under this sub-section shall be inconsistent with this Act or with any bye-law made under this Act.

Clause (*a*) *reads*—

The Commissioner may, in such cases as the Standing Committee shall either generally or specially direct, instead of levying the water-tax in respect of any premises liable thereunto under section 141, charge for the water supplied to such premises by measurement at such rate as shall from time to time be prescribed by the said Committee in this behalf ;

Clause (b) reads—

The Commissioner may, with the approval of the Standing Committee, compound with any person for the supply of water to any premises for a renewable term of one or more years not exceeding five on payment of a fixed periodical sum in lieu of the water-tax or charge by measurement which would otherwise be leviable from such person in respect of the said premises.]

(*ii*) when payment for the water is not made by measurement, to permit any person not residing on premises in respect of which water-tax is paid to carry away from such owner's or occupier's premises water derived from the municipal water-work ;

(*e*) if the owner or occupier of the premises wilfully or negligently injures or damages his meter or any pipe conveying water from any municipal water-work.

(2) The expense of cutting off the connection or of turning off the water in any such case as aforesaid shall be paid by the owner or occupier of the premises.

280. No person to whom water is supplied by measurement or on payment of a fixed periodical sum, shall contravene any condition prescribed under sub-section 2 of section 169 for the use of such water, or permit any such condition to be contravened.

281. No water-pipe shall be laid in a drain, or on the surface of an open channel or house gully, or within 20 feet of a cesspool, or in any position where the pipe is likely to be injured or the water therein polluted ; and no well or tank, and except with the

consent of the Commissioner, no cistern shall be constructed within 20 feet of a privy, water-closet or cesspool.

282. (1) No person shall fraudulently dispose of any water supplied to him by the Corporation.

(2) No person to whom a private supply of water is furnished by the Corporation shall, except when the water supplied is charged for by measurement, permit any person who does not reside on the premises in respect of which water-tax is paid to carry away water from the premises to which it is supplied.

(3) No person, who does not reside on premises in respect of which water-tax is paid, shall carry away water from any premises to which a private supply is furnished by the Corporation, unless, in any case in which such supply is charged for by measurement, he does so with the permission of the person to whom such supply is furnished.

283. (1) No person shall fraudulently—

(*a*) alter the index to any meter or prevent any meter from duly registering the quantity of water supplied;

(*b*) abstract or use water before it has been registered by a meter set up for the purpose of measuring the same.

(2) The existence of artificial means under the control of the consumer for causing any such alteration, prevention, abstraction or use shall be evidence that the consumer has fraudulently effected the same.

General Provisions.

284. No person shall wilfully or negligently—

(*a*) injure or suffer to be injured any meter belonging to the Corporation or any of the fittings of any such meter;

(*b*) break, injure or open any lock, cock, valve, pipe, work or engine appertaining to any municipal water-work;

(*c*) flush or draw off the water from any such water-work, thereby causing such water to be wasted;

(*d*) do any act whereby the water in or derived from any municipal water-work shall be wasted;

(*e*) obstruct, divert or in any way injure or alter any water-main or duct.

285. Compensation shall be paid by the offender for any damage which the Corporation sustains by reason of any contravention of section 283 or section 284.

286. If it shall be shown that an offence against some provision of this chapter or against some bye-law made under this Act at the time in force relating to water-supply has occurred on any premises to which a private supply of water is furnished by the Corporation, it shall be presumed, until the contrary is proved, that such offence has been committed by the occupier of the said premises.

287. (1) On the written request of any person who is required under any of the provisions of this chapter to supply any materials or fittings or to do any work, the Commissioner may, in such person's behalf, supply the necessary materials or fittings or cause the necessary work to be done; but he shall not do so in any case to which the provisions of section 493 or 495 will not apply, unless a deposit is first of all made by the said person of a sum which will, in the opinion of the Commissioner, suffice to cover the cost of the said materials, fittings and work.

[*Sections* 493 *and* 495 *read as follows*:—

Instead of recovering any such expenses as aforesaid in any manner hereinbefore provided, the Commissioner may, if he thinks fit and with the approval of the Standing Committee, take an agreement from the person liable for the payment thereof, to pay the same in instalments of such amounts and at such intervals as will secure the payment of the whole amount due, with interest thereon at the rate of nine per centum per annum, within a period of not more than five years.

495. (1) Improvement expenses shall be a charge on the premises in respect of which or for the benefit of which the same have been incurred and shall be recoverable in instalments of such amounts not being less for any premises than twelve rupees per annum, and at such intervals as will suffice to discharge such expenses, together with interest thereon at the rate of six per centum per annum, within such period not exceeding thirty years as the Commissioner, with the approval of the Corporation, may in each case determine.

(2) The said instalments shall be payable by the occupier of the premises on which the expenses are so charged or, in the event of the said premises becoming unoccupied at any time before the expiration of the period fixed for the payment of such expenses or before the same, with interest as aforesaid, are fully paid off, by the owner for the time being of the said premises, so long as the same continue to be unoccupied.]

287. (2) No person shall permit any work, which he is required to do under any of the provisions of this chapter, to be done except through the agency of a licensed plumber, and any person who causes or allows communication-pipes, or any fittings or work necessary for conveying a private supply of water from a municipal water-work into any premises, to be laid, appplied or executed by any person other than a licensed plumber shall not be entitled to demand a connection with the municipal water-work.

287*a*. (1) The Commissioner may, if he thinks fit, cause any work described in this chapter to be executed by municipal or other agency under his own orders, without first of all giving the person by whom the same would otherwise have to be executed the option of doing the same.

(2) The expenses of the work so done shall be paid by the person aforesaid, unless the Corporation shall, by a general or special order or resolution, sanction, as they are hereby empowered to sanction, the execution of such work at the charge of the Municipal Fund.

288. The Commissioner may supply water from a municipal water-work to any local authority or person without the city on such terms as to payment and as to the period and conditions of supply as shall be, either generally or specially, approved by the Corporation.

BOMBAY WATER WORKS.

The City of Bombay is supplied from four different lakes situated at some distance from the City. Of these four, practically three only supply water to the City proper, *viz.*, Vehar, Tulsi and Tansa.

Vehar Lake.

Vehar lake has a gathering ground of 2,500 acres. Its full capacity is 8,800 million gallons. The mean rainfall for several years past is 84·70 inches. The water of this lake is conveyed to the City by means of cast-iron pipes of 24 and 32 inches diameter. The 24 inch pipe discharges direct into the distributing mains and the 32 inch pipe into the Bhandarwada Reservoir. The mean evaporation comes to about 36⅗ inches. The depth of the lowest outlet below overflow level is 32 feet. The greatest depth of water stored is 59 feet. The height of the lowest draw-off on the T. H. Datum is 232·15.

Tulsi Lake.

The second of these lakes is Tulsi. The area of its gathering ground is 1,385 acres. It has two dams; the height of the lowest draw-off on the T. H. D. is 400 ; capacity available, when the lake is full, 2,306 million gallons ; mean rainfall comes to 103·82 inches ; mean evaporation is $36\frac{5}{8}$ inches ; depth of lowest outlet below overflow level is 57 feet ; greatest depth of water stored is 57 feet. It was constructed in 1879, and is 19 miles from the Town Hall of Bombay. The water is brought into the City by means of cast-iron pipes 24 inches in diameter laid generally above the level of the ground, and discharging into the Malabar Hill Reservoir.

Tansa Lake.

Tansa is the largest lake. The area of gathering ground is 33,600 acres ; there is only one dam ; height of lowest draw-off on the T. H. D. 380 feet ; capacity available for supply when the lake is full, 18,600 million gallons ; evaporation is about 3 feet ; depth of the lowest outlet below overflow level is 25 feet ; greatest depth of water stored is 110 feet : average rainfall comes to 106 inches ; it is 58 miles from the Town Hall of Bombay. It was finished in 1891. The water is brought into the City by means of a masonry conduit as far as practicable. The syphons across the valleys are of cast-iron pipes, 48 inches in diameter, laid generally below the surface of the ground.

The Filtering Beds.

The Malabar Hill beds are 8,546 square yards in area and comprise 7 beds varying from 1,425 square yards to 1,006 square yards in area. The depth of water over the sand is 4 feet. The filters are scraped once in every 3 to 5 weeks, when practically only the scum is removed, the sand removed being hardly $\frac{1}{8}$th of an inch in depth.

The filtering medium consists of—

Large Shingle (1 inch mesh)	3 inches.
Fine Shingle ($\frac{1}{2}$ inch mesh)	3 ,,
White River Sand	12 ,,
Basaltic..	12 ,,

At Bhandarwada there are 9 filters varying from 1,701 to 1,835 square yards in area and amounting in all to 15,632 square yards. The depth of water over the filters varies from 2 to 3 feet. The filters are composed of shingle 6 inches and fine sand 2 feet 6 inches.

At Vehar there are five filters giving a total area of 3,044 square yards. The head is 3 feet and the filters resemble those of Bhandarwada, *viz.*, shingle 6 inches and fine sand 2 feet 6 inches.

The maximum rate of filtration is 624 gallons per square yard per day. The rate of filtration is controlled by means of regulating valves, penstocks at the outlet end of each filter and sluice valves at the intake end.

CALCUTTA WATER WORKS.

In Calcutta the river Hooghly forms the water-supply. The river is tidal at the intake and at high tide it is more or less salt. The raw river water is also very turbid varying from month to month, the total solids being sometimes as high as 1 in 1,000 in the early rains. The water is pumped from the river into settling tanks during the last hour of ebb and the first hour of flow of the tide. During the rains the water is treated in the settling tanks with alumina ferric (1 to 2 grs. per gallon). This leaves a comparatively clean water, which is drawn off from near the surface of the tanks and then passes to sand filters. The cost of this treatment is about 1 Rupee per 1,000,000 gallons. The use of alumina ferric has been found to reduce the turbidity by as much as 75 per cent. after 24 hours' settlement, whereas when untreated, the same water has shown only 30 per cent. reduction after 40 hours' settlement.

LEEDS WATER WORKS.

The water is collected in a reservoir of 195 acres in extent. From this reservoir it passes to a settling tank of 3 acres in extent and from thence to the filter beds, each of which is nearly an acre in area. Each filter bed consists of fine sand 2 feet, pea sand 3 inches, ½ sand 3 inches, 1 inch gravel 4 inches, and rough stones 9 inches. The water after passing through these beds enters a series of perforated pipes 3 to 4 inches in diameter, all of which discharge into a main culvert in the centre terminating in a small circular covered tank, from whence it goes to the service reservoir. When the filters are cleansed, about ¼ to ⅜ inch of sand is removed.

When the filter tanks are emptied for cleansing, the water is only drawn off to near the bottom of the sand and in refilling the water is backed up from below. The air in the sand escapes not only from the surface but also from escape pipes in the side of the tanks. On the average each square yard passes 412 gallons per 24 hours. The head used is about 4 to 4½ feet.

Filtration must not be too rapid and should not exceed 2,000,000 gallons per acre per day. To accomplish this the filtering head must be reduced after cleansing and gradually increased as the pores of the sand become closed by the slimy matter which settles on the surface. By 'filtering head' is meant the difference between the level of water on the bed and that in the receiving tank. Each filter bed should have its own regulating apparatus to control the head of water at any given time and thus maintain an even rate of filtration, as otherwise bacteria may pass through, the number passing depending largely on the rate of filtration.

In the Metropolitan Water Board's Works the water passes from storage reservoirs on to filter beds composed of layers of gravel (fine and coarse), above which is 3 feet of fine sand. The depth of water on the filter is about 2 feet and the average rate of filtration is 1,600,000 gallons per acre per day.

CHAPTER V.

FOOD AND MILK.

Man is, in practice, omnivorous; he, however, adopts such food as is suitable to the environments and the climatic conditions he lives in, and to the daily pursuits of his life, whether active or otherwise. Thus the inhabitants of extremely cold climates take large quantities of animal food with fats, as it serves a double purpose, nutritive and heat producing. In temperate climates, other conditions prevail and the people adopt a food suited to the physiological requirements of a temperate climate. The food is of a mixed nature, consisting both of animal and vegetable products. In tropical climates the conditions are entirely changed. The temperature is such as not to demand a continuous supply of a heat producer; besides, the land produces an abundance of vegetables, fruits, etc., which are more agreeable to taste and more easy of digestion.

A brief review here of how inhabitants come to adopt a food, suitable to the environments and climatic conditions they live in, will be instructive.

From times immemorial, India has always been coveted on account of its fertile lands. The first invasion was that of the Aryans. They came down from the north of the Pamirs in Central Asia and occupied fertile lands in the Punjab along the Indus and its tributaries, whence at different periods further migrations were made down south.

In the Central Asian wilds their habits were nomadic, partly martial and partly agricultural. Their chief occupation and pleasure in life was hunting and hence they were essentially meat-eaters; but in the land of their adoption, in this very early period, "the Vedic" Aryans indulged in a variety of foods. R. C. Dutt, in his "History of Civilisation in Ancient India" (Vol. 1, Page 5) says "there were no temples or idols. Each patriarch of a family lighted the Sacrifical Fire in his own hearth and offered milk and rice offerings or animals or libations of 'Soma' juice to the fire, and invoked the "bright" Gods for the blessings of health and wealth for himself and his children"; and later, on page 41, says :—"It may be easily imagined that animal food was largely used by the early Hindus of the Punjab. In the Rig-veda there are frequent allusions to "the cooking of cows, buffaloes and bulls" and there is also mention of a "slaughter house" where cows were killed. The fermented juice of the plant "Soma" appears to be the only intoxicating drink used in the Vedic times. This drink was heavily indulged in by the Aryans and their cousins, the Iranians."

On account of the fertile nature of the soil, however, they took largely to agriculture. As a result, under the altered climatic conditions and with an abundance of agricultural products, they, to suit the existing conditions, adopted a diet of a mixed nature which by experience they found supplied the same quantity of physical energy as in days of old. In course of time the settlers adapting themselves to the conditions of their land of adoption led a life different from what they were wont to. Their customs, social habits and religious ideals changed (Epic period) with these new standards in life and concommittantly with them also in relation to food stuffs. This was the era of the evolution and development of the great religious caste system of Hindus.

Those who still kept to active pursuits in life consumed mixed diet, but those whose pursuits were mainly religious and literary became gradually purely vegetarian. Their needs were few and the consequent waste in the human economy was easily made good by vegetable diet which *included* milk!

Other eyes, however, coveted the fertile plains of India, and the Greeks of Bactria and the Turanians invaded India. The former introduced Greek civilisation and culture into Western India. The latter established the kingdom of Kashmere and its dependencies. Later, the martial and marauding Tartars and Berbers began to make invasions and inroads into India. The "far seeing" Manu promulgated the new code of castes, by means of which he secured the defence of the country and, at the same time, yielded to the high ideals of the religious and literati. He therefore divided the people into two great sects : the martial, the Kshatrias and the religious, the Brahmins. To the former he allowed mixed diet consisting both of meat and vegetable, which were necessary for the up-keep of the human physique, the supply of physical energy and the repair of waste tissue. On the latter (Brahmins) he enjoined a purely vegetable diet, in which milk was included.

Guided by experience, and in conformity with both social and religious customs, the Aryan Hindus adopted the mixed diet as the best and most suited to the climatic conditions.

Mixed diet may be of two kinds :—(1) a mixture of animal meats consisting of albuminates, and vegetable food and sugar (wheat, rice, etc.,) containing starches, *i.e.*, carbo-hydrates. (2) Vegetable matter only, *i.e.*, cereals containing vegetable albuminates in addition to starches or sugars.

To both the above there is always a proportionate admixture either of animal fats or vegetable oils, butter or ghee.

In the human system provision is made for the digestion of animal and vegetable albuminates, starches or carbo-hydrates, and fats and oils. In the mouth, in the process of mastication and trituration, the food is intimately mixed with saliva which contains a ferment, "ptyalin," by the action of which starchy and farinaceous foods are dissolved and converted into soluble sugar compounds ready for assimilation and absorption. In the stomach, there is the gastric juice containing a ferment called "pepsin," which acts on albuminoid and protein compounds converting the same into soluble and easily absorbable forms called "peptones." The portions of food not absorbed in the stomach, being only partially digested, pass into the intestine which receives secretions from two large and important glands, the liver and the pancreas.

The secretion of the liver is bile. By its action the animal fats and vegetable oils are emulsified and sapronified and rendered easy of digestion. The pancreas supplies the pancreatic juice possessing peculiar properties which enable it to perform the double function of both the gastric juice and saliva. This special action is due to the three ferments it contains, namely, (1) trypsin, (2) amylopsin and (3) steapsin. Trypsin further peptonises and splits the peptones up into leucin and tyrosin and asparmatic acid, crystalline nitrogenous substances very different from proteids. Trypsin is, in all respects, a more powerful ferment than pepsin : it reduces peptones into more easily absorbable products. Amylopsin or sugar-forming ferment changes starch into dextrin and maltose just like ptyalin of saliva. Steapsin or fat-splitting ferment splits up fats into glycerine and corresponding fatty acids ; the latter acids unite with the alkalies of the pancreatic juice and bile which emulsifies and sapronifies fats and oils. As digestion proceeds, the food is reduced first to a sloppy condition and finally to a liquid state. This fluid is of a milky consistence and is called chyme ; as it passes downwards it is absorbed by hair-like processes called villi, which project from the walls of the intestine, and from these it soon passes into the blood vessels with which the intestine is abundantly provided.

Besides the albuminates, carbo-hydrates and fats and oils, there are other adjuncts which are necessary for the preservation of health. These are water, mineral salts, and acids, chiefly vegetable.

Water.—In the human system the percentage of water to the body weight is about 62 and the body loses about 100 ounces daily. The necessity for water is therefore obvious ; it must compensate for the losses caused by the excretory organs and skin. Its presence is a necessary condition for the occurrence of chemical changes in other bodies in the human system. It is valuable for the dilution and solution of solid foods, whereby they are easily digested and assimilated. Moreover, it is a necessary constituent of all body tissues.

The quantity required by each individual varies according to the bodily labour and the temperature he lives in. The more the functional activity of the body organs,the more is the need of water.

Water, the principal beverage of man, should therefore be as pure as possible. Water is liable to be rendered impure by inorganic or organic matters, or to be contaminated by sewage impurities and by active pathogenic germs. The inorganic impurities may be due to active poisonous mineral matters held in solution, such as lead, or due to alkaline or earthy salts derived from the soil, or similar salts derived from the decomposition of organic substances. Water containing such impurities has deleterious effects on health. Minerals and salts produce intestinal disorders, chiefly Diarrhœa; calcium sulphate, chloride and nitrates produce Diarrhœa, or Dyspepsia, and magnesium salts appear to be concerned in the production of goitre. Lead salts give rise to chronic lead poisoning, iron salts produce constipation. Inorganic impurities may also be held suspended in water, and, when such water is imbibed, may produce gastric irritation and even Muco-Enteritis. Hill Diarrhœa in India is caused by very fine mica scales held in suspension in water.

But when water is contaminated by sewage impurities, fæcal matter, or active pathogenic germs, diseases of a more serious nature or even epidemics may be caused. The principal water-borne diseases are (1) Cholera, due to Comma bacilli; (2) Enteric or Typhoid Fever, due to Eberth bacilli; (3) Dysentery due to Amœba coli.

For the causation of the above diseases, specific infection by means of the particular pathogenic germ is necessary. Water when stored, or well water, or even running water may be infected by the washings of a stool containing these specific pathogenic germs. When a water supply is infected, the outbreak is sudden and spreads rapidly in the locality to which the water supply is given, and thus gives rise to an epidemic. Sporadic cases may occur by the specific infection being conveyed by other means. Vegetable salads, either grown in contaminated soil, or watered by water fouled with such specific infection, may give rise to such cases, and experience has proved that this is a frequent cause of infection.

Drinking water may constitute the common medium by which certain parasites (Entozoa) may gain access to the intestines of man. The chief of these are the following :—

(1) Bilharzia Hæmatobia or Schistosomum Hæmatobium. This trematode gains access to the human system through drinking water, or by its miracidia, from the evacuated eggs, penetrating through the skin of man while in the process of bathing. It lives in man in the portal vein and its branches and is distributed to the veins of the abdomen, particularly those of the pelvis or bladder and rectum. The manifestation of the disease, most frequently, is in the bladder, where at first there is catarrh, and is followed by sanguinous urine or hæmaturia.

(2) Ascaris Lumbricoides, or the round worm, sometimes enters the system through drinking water infected with their eggs.

" At Moulmein in Burmah during the wet season, especial-" ly at its commencement, natives and Europeans, both " sexes, and all ages, were in former years so affected by " lumbrici as almost to constitute an epidemic. The only " circumstance common to all classes was that the drinking " water, drawn chiefly from shallow wells, was greatly con-" taminated by the substances washed in by the floods of the " excessive monsoon " (Notter and Firth). The normal habitat of this worm is the small intestine. It however wanders all over the alimentary tract, and may be discharged by vomitting or by the stools. The ova of this worm develope in water or moist earth, after a long period of incubation. In medium temperature it takes about 30 to 40 days for the embryo to become formed. The spirally rolled up embryo never leaves the egg shell in the open. In this condition it gains access to the intestine of man and takes about 4 to 5 weeks to develope into young worms. The infection occurs partly through water but principally direct from the soil.

(3) Oxyuris Vermicularis, or the thread worm, is one of the most frequent and widely spread parasites of man. It occurs principally in children and its normal habitat is the large intestine. There the male and female oxyuris live

and reproduce. The male rapidly dies and disappears, and that is why it is rarely met with in the excrement. The female remains very active and often leaves the tract through the anus and causes very troublesome itching. The ova also pass out and may infest man through water or be transferred directly from person to person by the hand and re-introduced into man *per os.*

(4) Guineaworm or Filaria Medinensis is very common in tropical climates. Filaria Medinensis was known to the ancient Arabs, and is most prevalent in Medina (Arabia), Persia, Turkestan and India. The Medina worm is widely distributed in Africa and is identical with what is generally known as guineaworm. In adult stage it lives beneath the surface of the body, most frequently under the skin, in the lower extremities, chiefly about the ankles. It may also occur in other parts of the body. The male worm is very small and generally dies after attaining maturity. It is the female worm that burrows under the skin. Dr. Max Braun, in his book " Animal Parasites of Man," says " it was known since the most remote period. 'The fiery serpents' that molested the Israelites by the Red Sea and which Moses mentioned were probably filariæ ." The larvæ of the worm reach the open after the bursting of the mother's body. They live in water and moist soil. The larvæ enter the body of a cyclops through its integuments and there undergo development and are thus taken in with drinking water.

(5) *Filaris Sanguinis Hominis* is the cause of Elephantiasis, of Chyluria and Hæmaturia in man. From the blood of an affected patient the embryo is sucked up by a female mosquito, in whose stomach it undergoes development. The mosquito resorts to water to deposit its eggs and there perishes ; the filariæ are thus set free in water, whence they find their way into the human body, either through drinking or bathing. The habitat of the adult worms is the lymphatic vessels. The filarial larvæ may be directly inoculated into man by a mosquito bite.

(6) *Distoma Hipaticum*, or the liver fluke, inhabits the bile ducts of numerous herbivorous animals, chiefly sheep, ox, goat, buffalo, horse. It occurs equally in all climates.

In India it is chiefly found in the liver of the buffalo and in Burma in that of sheep. In the latter animal it produces a disease known as 'Sheep Rot.' Its habitat is the liver which it gradually atrophies. The eggs of liver-flukes develope in water and the larvæ miracidia penetrate into a water-snail common in fresh water and become sporocysts, and these are further developed into young redia which become encysted on the meadows and are taken up by herbivorous animals with their food. The liver fluke is extremely rare in man : only 23 cases have so far been observed. The liver-fluke feeds on blood.

(7) *Ankylostoma Duodenale* is also called the tunnel worm or hook-worm. The American hook-worm is called Uncinaria Americana. The ankylostoma is found all over the world. It is very common in India. It is also most frequently found in warm, damp mines where sanitation is defective; hence miners suffer most from it and the disease is commonly called Tunnel or Miners' Disease. The normal habitat of the worm is the duodenum, and more rarely the first part of the jejunum. It is parasitical in human beings. The disease is due to the manner of nutrition of the parasite. The worm sucks blood with its head sunk deeply into the mucous membrane of the intestine. It constantly leaves the spots it has attacked, so secondary hæmorrhages occur; in addition to the diseased condition of the intestine, it has considerable effects on the nutrition of the patients ; possibly also toxins are produced which have a pernicious effect on the host. It produces Chlorosis. Recently, during the construction of the tunnel St. Gothard, the labourers suffered severely from Ankylostomiasis. Miners and pitmen suffer from the disease. The male worm is smaller than the female, but both attack the host by their buccal end which contains claw-like hooks, through which the worm sucks the blood. The female produces a very large number of eggs, which reach the open through the fæces. The larvæ are then developed, which consist of minute organisms very mobile and active. In the larval stage it lives in muddy water or wet, damp soil. The larvæ may gain entrance into the alimentary canal through the drinking of such water,

or through food eaten with soiled or dirty hands. Recently, Loos has discovered that larvæ of ankylostoma enter the human body through the skin. The larvæ placed on the skin with a drop of water penetrate the hair follicles in a short time. When the larvæ attack the skin in large numbers, inflammation of the skin occurs—a dermatitis commonly known as "cooly itch." They gain access to the venous system directly or through the thoracic duct and are then conveyed to the lungs, where they develop further, and are conveyed by the mucous secretion into the bronchi and trachea and out of the glotis, passing down into the æsophagus and lastly into the duodenum, where they further mature and develop into full worms.

The American hook-worm or Uncinaria Americana differs from the ankylostoma duodenale in the following particulars. It is shorter and more slender with the buccal capsule smaller, and instead of the four ventral hook-like teeth, it is provided with a ventral pair of semi-lunar plates, similar to those of the dog hook-worm. (Uncinaria stenociphala) ; deep in buccal capsule are one pair of dorsal and one pair of ventral submedian lancets. This worm is also called Necator Americanus, and is said to occur in Madras, Burma and Assam.

The disease caused by these worms is termed "Ankylostomiasis."

Vegetable acids of fruits and vegetables have a beneficial effect on the well-being of the individual. They occur as salts of citric, tartaric, malic, oxalic, lactic and acetic acids, and are converted into carbonates which produce the alkalinity, which is a necessary character of the normal constitution of blood and other fluids of the body; when deficient or absent from the food, a state of malnutrition occurs which, if continued, finally developes into scurvy.

Salts are as essential to the body as nitrogenous principles. The chief are common salt, phosphates of lime, soda, potash, magnesium and iron. Common salt occurs in all tissues and fluids of the body and promotes the solution and diffusion of fluids through membranes. The phosphates help in the development of bone.

Dietaries of individuals differ according to the nature of their occupation, according to the body weight and physical labour or energy employed. The latter two include (1) internal mechanical work which is required for the maintenance of circulation, respiration, digestion, etc., and (2) external mechanical work expended in movement or locomotion, lifting and carrying weights, etc. There is also mental work or nervous energy spent to be considered. The internal mechanical work is performed automatically by the heart and the organs and is estimated at 260 foot-tons, *i.e.*," it is equivalent to the work which a man does who raises 260 tons to the height of one foot. The average external work, also called productive mechanical work, is estimated at 300 foot-tons."

The average weight of a European is between 140 to 150 lbs. The average weight of an Indian is about 115 lbs.

The ordinary work of a European labourer is estimated at 300 foot-tons, and *pari passu* that of an Indian must be estimated at a lower figure—220 foot-tons. Dietaries, therefore, are calculated according as the diet is necessary for—

(1) subsistence, just sufficient for the internal mechanical work of the body ;

(2) ordinary work (consumption of visible energy equivalent to 300 foot-tons) ; and

(3) laborious work : to compensate a work equivalent to 450 to 500 foot-tons.

It follows, therefore, that a large proportion of albuminoids to starch and oil is naturally required for those whose stress and amount of work are greater.

By means of chemical analysis, the relative proportions of proteids (albuminates), carbohydrates (starch), water and mineral matter in each of the various foods have been ascertained. On this basis estimates have been made, and it is found that the " nutritive value " of vegetable (proteids) foods is almost equal to that of corresponding proteids of animal foods.

Prof. A. H. Church, in his hand-book on "Food Grains of India" (page 14) says: "the expression 'nutrient value' refers to the sum total of the albuminoids, starch and the starch equivalent of oil, and the term 'nutrient ratio' designates the proportion of albuminoids to starch, including with the starch, the starch equivalent of any oil or fat present in the food." A complete nutrient ratio will necessarily include besides the above, water and saline and mineral salts. It has been found by experiments that one part of vegetable oil or fat is practically equal to 2·3 parts of starch, and for reckoning purposes the factor 2·3 is used as the "starch-equivalent" of one part of oil.

By practice, it has been ascertained that the 'nutrient ratio' in good standard diets of nitrogenous food to non-nitrogenous, or, which is the same thing, of albuminates to carbohydrates should not be less than 1 to 6, and this proportion has been fixed in the construction of a standard dietary for a European weighing 150 lbs. and doing moderate work.

For hard work more nitrogenous food is necessary for the repair of tissue and loss by heat of physical energy. Consequently, for hard work, in the calculation and construction of a diet for such individuals, a higher proportion in nutrient ratios must be aimed at to compensate the loss; hence more nitrogenous food and (equivalent) proportional rise in carbohydrates.

Prof. Church referring to Indians says (page 19):—"If "then, we assume an amount of daily work performed by an "average European labourer weighing 150 lbs. can be expres-"sible in this form—that he lifts 300 tons one foot—we shall "find that the natives of India weighing 115 lbs. can and do "perform an amount of daily work equal to 230 foot-tons, "and, if their weight be 105 lbs., they can and do accomplish "work equal to 215 foot-tons." On the above basis, he gives the following standard dietaries for Indians weighing 105 lbs. expressed in ounces avoirdupois. If the Indian weighs 115 lbs., one-tenth must be added to the calculated quantities—

Standard Table for Indians weighing 105 *lbs.*

——	Albuminates.	Oil.	Starch.	Starch equivalent.	Nutrient ratio.
A. Bare sustenance ...	2·123	0·752	7·520	9·250	1 : 4·34
B. Moderate work ...	2·954	1·412	12·531	15·779	1 : 5·34
C. Hard work ...	3·635	2·506	18·190	26·954	1 : 4·66

For an average European weighing 150 *lbs. the following table gives approximately the dietaries under the same conditions. On comparing the two, the excess required by the European will be at once patent. These are also expressed in ounces avoirdupois.*

——	Proteids.	Fats.	Carbohydrates.
1. Subsistence diet	2·33	0·84	11·69
2. Moderate work	4·215	1·397	28·69
3. Active labour	5·41	2·41	27·92
4. Hard work	5·64	2·34	20·41

It will thus be observed that mixed diet is the most suitable diet for man. In nature there does not exist any complete food having the adequate proportions of nutrient ratios of a mixed diet. Even milk, the ideal food for infants and growing children, is not a complete food in the sense required by an adult, inasmuch as it contains no starch, for the digestion of which two specific ferments are provided in the human system, namely, saliva and pancreatic juice. It contains a large proportion of water and relatively large proportion of fats in comparison to the proteids and carbohydrates. Eggs have all the necessary nutrients for an adult but are deficient in carbohydrates and hence cannot be a complete and perfect food.

To calculate and construct a suitable mixed diet, only experience can be our best guide. It should be small in quantity, easily digestible, agreeable to taste and of good quality. All these various attributes can readily be obtained in a mixture of animal and vegetable foods. Vegetables alone, cereals and pulses may contain all the necessary ingredients, but the quantity required must necessarily be larger so as to attain a proper nutrient ratio, and because of its bulk it is less easily digested and liable to undergo fermentation in the alimentary digestive tract. Therefore, if by custom and religion a mixed diet made up of ingredients of both animal and vegetable stuffs is prohibited, a selection of cereals, pulses and vegetable oils must be made and so adjusted as to obtain a complete food with the minimum of quantity and maximum of digestibility.

Regarding food grains of India, cereals and pulses, exhaustive analyses and researches have been made by Dr. Forbes Watson and later by Professor A. H. Church, and the exact ratios of each of the different varieties of grain and pulses ascertained. The nutrient values of these foods are tabulated and dietaries proposed and incorporated in the hand-book on "Food Grains of India," to which reference may be made in computing diets of a vegetable nature only.

The ailments due to excess of food, either too large or too frequent meals, require no special mention. Unwholesome food or food in a state of partial decomposition produces symptoms of severe gastric irritation due to ptomains and other toxins which such food contains.

All meats of animals suffering from infectious or acute inflammatory diseases must be entirely prohibited. A reference will be made here to such foods, animal or vegetable, used in these countries, which may be the carriers or be the cause of the production of particular diseases in man.

Animals in tropical climates suffer from the same kind of parasites as in colder climates ; the chief of these are Tenia Solium from the Cysticercus Cellulosæ of the pig, and Tenia Mediocanelata from the Cysticercus Bovis of the ox. These cysticerci occur as small bladder-like bodies in the muscles. Such meats ought to be rejected, but may be rendered innocuous by efficient cooking. If not properly cooked and the cyst is ingested, it undergoes certain changes and developes into a tape worm in the small intestines. A few years ago tape worm was very common in Bombay, especially among the poorer Mahomedans, as these indulged in contraband meat (buffalo and ox) brought stealthily into the City ; much has been done by the Health Department and the Market Department of this City to prevent the importation and the sale of such flesh, and large quantities of such meat are seized and destroyed and the offenders prosecuted from time to time under section 412 of the City of Bombay Municipal Act. The tape worm now is not probably so prevalent as it used to be, as only a few cases come to the notice of the Health Department.

Pig or pork meat is prohibited to Hindus, Jews and Mahomedans. They hold the pig in abhorrence not only because it is so ordained by religion but because of its foul habits as it supplants the scavenger. Christians and the Chinese indulge in fresh pork meat and are liable to suffer from Tenia Solium, if these victuals are not rendered innocuous by efficient cooking.

Trichiniasis is a disease occurring in colder climates and is due to tiny cysts enclosing Trichina spiralis ; this disease must be entirely rare in this Presidency, as no cases are reported. Flesh of animals suffering from the following diseases must be condemned :—(1) Variolous Diseases, (2) Rabies, (3) Glanders, (4) Foot and Mouth Disease, (5) Anthrax, (6) Tuberculosis.

Another tenia which occurs in man is Tenia Ecchinococcus hominis. It is really the cysticercus stage of the adult tenia, which lives in the small intestines of the domestic dog and the wild jackal and wolf. The cysticercus stage lives chiefly in the liver and lungs of sheep, ox, pig and buffalo. It is not uncommon in man in this stage, though the adult tenia has never been found in man. The only source of infection in man is the ingestion of the oncospheres (eggs) of the dogworm. Dogs disseminate the oncospheres wherever they go, and the dog being in close association with man, this can be the only source of human Ecchinococcus disease. It will also be easily understood how cattle become infected ; the eggs voided by the dog find access to hay, grass and straw and water which are consumed by cattle ; so also they may gain access directly to man by means of uncooked vegetables, lettuces, etc. But the most frequent source of infection is the caressing of dogs. Ecchinococcus is very frequent in slaughtered animals, especially sheep, oxen and buffaloes. It occurs chiefly in livers and lungs, and it is best to condemn such flesh. When it occurs in man it is called the hydatid cyst ; it is a spherical bladder containing greenish yellow liquid and other smaller cysts known as daughter cysts containing one or more Ecchinococcae scolices, the predecessors of the adult tenia. The hydatid is rare in children up to 10 years of age, but it is most frequent in women.

Fish is extensively eaten in the tropical climates, and along the coast, where fish abounds, it forms one of the chief ingredients in the dietaries of the people. Fish must be fresh and must be eaten as early as possible after being caught. In hot climates fish rapidly loses its freshness. Stale or partly decomposing fish is poisonous. It produces symptoms of Gastro-Enteritis. Fresh fish is always firm and stiff : any drooping of the tail indicates staleness. Fresh fish has the slime clear and not discoloured, the scales are full and not dull or damaged, the eyes bright and not sunken and dull, the gills bright and red. If old, stale or starting to decompose, pressure between the finger and thumb produces an indentation and may separate the skin from the flesh. Fish is in perfect condition just before spawning and is then said to be " in season ; " during the process of spawning it becomes poor and thin and is " out of season." The flavour of fish depends upon the quantity of fat it contains and is also influenced by the food it takes ; carnivorous fish have a finer flavour than those which feed on vegetable food ; the former generally dwell in the sea and running streams, while the latter in muddy and stagnant waters.

All stale or decomposing fish must be forthwith condemned.

Fish is " cured " by salting and drying or by smoking. The entrails are always removed. The amount of nourishment in any given fish is not perceptibly affected by these processes; and cured fish may be reckoned as simply equivalent to fresh fish. The industry of salting and drying fish is lucrative, and the fisherfolk of coasting towns are engaged extensively in this trade. Unless fish is properly salted and dried by exposure to the sun, it is liable to decompose. Dried fish, with rice, forms the staple diet of the poorer classes in India. The "Bombay duck" commonly called "Bombla" or "Bombil" requires special mention. It abounds along the Bombay and Gujerat coasts. It is eaten fresh, but more frequently salted and dried. The fresh fish is sometimes poisonous and produces symptoms of acute Gastro-Enteritis but the cured is extensively eaten; both the rich and poor indulge in it. If not properly cured, it is liable to decompose and produce Gastro-Enteritis. If fish is caught in spawning season, the roe is taken out and salted and dried; for domestic use it is pickled and used as a dainty.

Fish is also preserved in oil in tins in India. On the Malabar Coast sardines abound and European Companies have established factories for the tinning and exportation of sardine. The Indian mackerel is salted and smoked and exported to other countries. The fish is said to be poisonous during spawning season. The popular belief is that stale or decomposing fish, or dry fish in a decomposing state, produces Cholera.

Shell fish, scientifically speaking, are not fish at all, they belong to the order of molluscs and crustaceans. Molluscs include oysters, mussels, clams, cockles, whelks and the crustaceans include crabs, lobsters, prawns, shrimps, etc. Of the first group, oysters and mussels are in great demand; of the second group all the four mentioned are sought for.

Oysters and mussels are generally eaten raw. Oysters when fresh and coming from a reliable bed are easily digestible and are reckoned a dainty, but, when they are collected from a bed to which sewage gains access, they are apt to be actively poisonous, producing symptoms of severe Gastro-Enteritis. Oysters may contain specific pathogenic germs, gaining access to them from sewage contamination. They have been known to contain Eberth's (Typhoid) bacillus, and to occasion local outbreaks of Enteric in persons indulging in oysters from contaminated beds, and the causation has been conclusively traced to this infection. Besides Eberth's, Bacillus coli and Bacillus enteridis sporogenes have been found in oysters from polluted beds. Deep sea-water oysters are free from these germs, and, therefore, perfectly harmless. Under certain circumstances oysters are able to transmit the infection of Cholera. If there be any suspicion that an oyster was grown in a contaminated bed, it is best to discard it; the bacillus lives both in sea-water and within the shell of the oyster. It has, however, been recently shown by scientists that oysters, mussels and cockles have the power of clearing themselves of infected germs partly by discharging them and partly by directly devitalising the microbe. Therefore, oysters coming from suspected waters should be deposited in pure water for a time before consumption, but it is best to eschew them altogether, unless eaten properly cooked. The above remarks also apply to mussels and cockles. Experiments have shown that Bacillus coli and Bacillus enteridis sporogenes are invariably found in these fish, especially in those coming from contaminated waters. These should be eaten properly cooked. The crustaceans, crabs, lobsters, prawns and shrimps should always be purchased alive and kept alive until the time of cooking, because their flesh decomposes very rapidly, and, when only slightly tainted, may produce disastrous results. Even when perfectly fresh, they are found to disagree with many people and give rise to minor disorders. Shell fish is generally said to produce "Urticaria." Mussels are particularly liable to be toxic. They suffer from enlargement of liver, wherein is produced an alkaloid (mitilotoxine) which produces in man symptoms like those of Curara poisoning. Mussels, in this condition are, even if stewed, poisonous.

Mussels should be tested by shaking them up in a bag; if they rattle and the shells open up, they should be condemned. Cockles when bad are found on opening the shell to be thin and when squeezed no liquid squirts from them. Crabs and lobsters should be examined under the apron and tail to see if they are discoloured. Crabs which after boiling are wet and sticky under the large claws are unfit for food.

Vegetable Foods.

Cereals are the complete fruits (grain or caryopsis) of the plants of the natural order Graminacæ. Speaking generally, rice and maize are the produce of hot climates, barley and rye of cold climates, while wheat is extensively grown in both climates. Cereals contain a very large proportion of starch, above 70 per cent. of the grain, while the albuminoid or proteid material differs in different cereals, ranging for 6·5 to 18 per cent. Vegetable oil or fat exists to a very small amount and salts represented by alkaline and earthy phosphates, although very small, are relatively large and important as nutritive substances ; it has also been observed that the larger the percentage of proteid matter the larger is the proportion of these phosphates.

Wheat is the richest in nitrogenous material, maize and barley rich in fats, while rice containing most starch is the poorest in nitrogen and fat. In the process of decortication and milling, wheat loses a large percentage of oil and mineral matter.

Wheat is the fruit-grain (seed) of the plant Triticum Sativa, sub-order Hordeæ of the Graminacæ. Wheat is grown all over the world. In India it thrives best where rice does not grow ; it does not grow in districts along the coast where rice abounds.

Indian wheat grain is not uniform in consistence and size but the variations are in the relative proportion of starch and nitrogenous substances and the change in mineral salts and oils is very infinitesimal. The albuminoid material rises or decreases according to the seed from 12 to 18 per cent., and there is correlative reduction in starch, about 6 per cent., which is not striking, as the reduction is small having regard to the large percentage of starch in wheat grain (about 70 per cent.).

Indian wheat is of two varieties, the white and red ; the former is rather soft and has an opaque kernel or endosperm and the latter a red and translucent, which indicates a large percentage of nitrogenous matters or albuminoids, while the former has a higher percentage of starch. The average composition of Indian grown wheat is—

Water	..12·5	per cent.
Albuminoids	..13·5	,,
Starch	..68·4	,,
Oil	.. 1·2	,,
Fibre	.. 2·7	,,
Ash	.. 1·7	,,

The nitrogenous matter or albuminoid in wheat consists of different substances—first *gladin*, mucin and fibrin constitute the crude 'gluten.' This substance may be readily obtained by kneading the flour with water and subsequently washing away the starch and soluble matters, which are two: albumin and cerealin. Gladin renders the gluten tenacious, stringy and elastic and this cohesive property renders wheat flour so adapted for making bread. Cerealin has properties akin to diastase, converting starch into dextrin and maltose. The carbohydrates are chiefly starch with a very small amount of dextrin and cellulose. The salts are principally phosphates of potash and magnesia; the nutrient ratio of wheat is 1:5, and nutrient value 84.

Wheat flour is extensively used in Indian dietaries. The old process, which even to-day obtains in mofussil towns and villages where there are no flour mills, is to grind the wheat grain between mill stones into meal (flour). In Presidency towns, even the very poor have their wheat ground at the flour mills which are established and worked by electric motors or small oil engines. In the City of Bombay such mills are dotted all over the place. The home (hand) ground flour is classified into three portions:—(1) *Sooji* is the coarse flour derived from the outer coat of wheat; (2) *Atta* is the finer flour from the middle portion; and (3) *Maida* is the flour of the innermost layer. *Sooji* and *maida* are employed in the preparation of Indian confectionery, whilst *atta* is used for making *chappattis* or *rotis*, unleavened bread. Flour is kneaded with water into dough, which is spread over on smooth surface to the required thickness, and baked over a fire or on a hot earthen platter. *Chappattis* are generally eaten with other vegetable foods or with milk or ghee. They are always eaten freshly prepared, as stale *chappattis* are dry and hard and consequently difficult of digestion. *Chappattis* prepared with ghee are more agreeable to the taste and keep longer. They form a part of every day meal among all well-to-do Indians.

Sooji and *maida* are used in the preparation of Indian confectionery. "*Halva*" so extensively sold in Indian bazaars is prepared by boiling *sooji* well mixed with ghee, sugar and water to the required consistence. It is dear and a heavy food.

Wheat or its flour may be rendered unwholesome by being kept in a damp place or being attacked by certain fungi, the most common being Puccinia graminis which produces the "smut" of the wheat. Vibrions may be present in damp fermenting flour. Acari farinae are also common in damp or inferior flour which is beginning to change.

Bread is also largely eaten in India. It is prepared in the same manner as in Europe, by addition of yeast to the dough or by addition of baking powders (alkaline carbonates with an admixture of tartaric acid) or by charging the dough with CO_2. Ordinary white bread is made from flour; brown bread is made from whole meal, and "whole meal" bread is made by addition of finely ground bran. This last variety is much used by persons suffering from chronic constipation, because of its laxative properties.

Biscuits are prepared from flour either plain with water or with addition of butter and sugar. They are baked until all the water is driven off, and without the use of yeast or any other means of raising the flour. Biscuits contain a large amount of nutrient material, and are also easy of digestion, and being dry keep a considerable time.

Rice constitutes the main food of the people of tropical countries. Rice is the produce of a grass plant Oryza Sativa, sub-order Oryzae, Graminacæ. It is extensively grown all over India and Burma; in some places so many as four crops are obtained annually. According to Prof. Church: "The analyses of a large number of samples of "cleaned" rice give figures which are wonderfully accordant, considering the difference in appearance of the specimens and the very diverse conditions under which they are grown." The following is the composition of rice :—

Water	12·8	per cent.
Albuminoids	7·3	,,
Starch	78·3	,,
Oil	·6	,,
Fibre	·4	,,
Ash	·6	,,

The nutrient ratio is 1 : 10·8 and the nutrient value is 86·5. The mineral matter consists of the phosphates of potash.

Rice is the staple food of the natives of India. It is obtained from *dhan* or paddy or unhusked rice by pounding. In many districts *dhan* is boiled and dried by being exposed to the air and then unhusked by pounding. Hulled or husked rice is called *chaul*. *Chaul* boiled and cooked is called *bhat*. In this process only so much water should be taken as can be absorbed by it; if boiled in a larger quantity of water, the mineral salts are dissolved out and lost as the excess of water is thrown away. Rice parched is known as *kurmurah*, and is used by labourers at midday meals and by travellers. In Indian dietaries rice is prepared in many ways with milk, sugar, molasses, cocoanut juice, etc.

Newly gathered rice is said to be unwholesome, as it is not easily digestible. It produces disorders of the alimentary canal, such as Diarrhœa and Dysentery. Rice is deficient in mineral salts and also nitrogenous matter; long continued use of this food alone deteriorates health, as the nutrient ratio is insufficient being 1 to 10 of albumen, while the standard ratio of perfect food is 1 to 5, a ratio which is present in wheat. It is, perhaps, because of this that the wheat-eater of the North of India speaks deprecatingly and disparagingly of the rice-eater of the South.

Maize or Indian Corn is largely grown in India, and is commonly called *macchai* in the north and as *butta* in the Bombay Presidency. The original home of maize or Zea Mays is South America. The seeds are large and yellow. Maize is rich in fatty oils amounting to as much as 5 to 8 per cent.; the proteids 9 to 12, carbohydrates 65, salts 1 to 2 and water 14. It is, therefore, very nutritious; but because of the large quantities of fat it is liable to become rancid and mouldy, and because of the deficiency in gluten it is not adapted for making bread. It has also a peculiar "harsh" flavour. Although not a very popular food, it is largely consumed by the peasant. The dry seed is ground into flour and prepared into a porridge or with milk into a pudding, or the whole seed is parched in hot sand and sold as "pop-corn." "Corn flour," extensively sold in Indian bazaars consists of maize flour deprived of its "harsh" flavour by treatment with a weak solution of caustic soda ; in this process it loses a considerable portion of proteids and fats, leaving only pure starch.

Barley is the grain of Hordeum Distichon. It is grown largely in cold climates and also in tropical countries. In commerce it is found with husk, and when ground with it forms *barley meal*. This is largely used as horse-food. When deprived of the husk it is called *pot-barley* and when further rounded it is called *pearl-barley*. Fresh barley ground into flour is called *patent* barley. *Malt* is the product of barley, yielded when it is allowed to germinate and germination stopped at a certain point by dry heat. Barley is not much eaten as food, but used in the preparation of malt and in the manufacture of beers and spirits. Barley flour is inferior to wheat flour as it contains very little gluten, and therefore unsuitable for making bread. Pearl barley is used for making "barley water," a pleasant and demulcent drink for the sick.

Oats are the product of Avena Sativa. In commerce it occurs in husk, but when unhusked it forms *groats*, the flour of which is *oatmeal*. In Scotland and the north of England it is largely used as food :(1) *oat-gruel*, (2) *porridge* and (3) *brose*. Gruel is made by boiling the groats with water or milk, and porridge by stirring the meal in boiling water until it comes to the consistency of pudding. Brose is prepared by treating the oatmeal in meat or cabbage soup. Oats are largely used as horse-food. It is a highly nutritious food, as it is very rich in fat (10 per cent.) and nitrogenous matter (16 per cent.), and that it is so is proved by the exceptionally good physical condition of the Highlanders. Others, however, do not appear to flourish on it, as porridge is apt to have an irritating effect on the intestines causing Diarrhœa. The nitrogenous matter is chiefly legumin with little or no gluten.

Rye (Secale Cereale) is largely cultivated in the colder climates, especially in Russia and Germany. Rye seed is not unlike wheat, but is darker and smaller. Rye is subject to a peculiar fungus disease due to a micelium of Secale Cornutum, which grows at the expense and in place of the grain producing what is known as *ergot of rye,* and which attains to about 3 times the size of the normal grain. It is black in colour and gives off a sickly odour and is of nauseous taste. If ergot-rye is allowed to germinate, it produces on its surface several club-shaped growths termed Claviceps Purpurea, which contain the spores; when these ripen they are liberated into the air, and find attachment to the pistil of a flower of rye and impregnate it, and thus the ergots of rye are developed. Pure rye is very nutritious as the percentage of proteids is about 10 and of fat 2. The proteids consist largely of gluten; hence rye flour can be made into bread; the bread is however dark, unpleasant to the taste and indigestible.

Ergots, because of their size, are easily sifted from the normal grain and collected and sold. Their active principle 'ergotine' and the extract and tincture are valuable drugs; their therapeutic action is well-known.

Millets are other cereals largely grown in India and consumed as food. They are the (1)great-millet or *joar,* the products of Sorghum Vulgare, (2) *bajra* or bulrush millet, the produce of Pennisetum Typhoideum, (3) *ragi natchni* of Eleusine Coracana, (4) *chena* or Indian millet of Panicum Meliaceum. As a rule, millets are the produce of an autumnal harvest. All these millets are smaller in size than the cereals (wheat, etc.) previously described, with the exception of Panicum Meliaceum or Indian millet, which has a high nutrient ratio (1 : 6) ; all the rest have very deficient ratios not unlike rice. These minor cereals form the staple diet of the hill tribes, and are also consumed by Indian peasantry during times of scarcity and famine. They are eaten as gruel (*canjee*) or made into cakes or scones.

Pulses are the seeds of leguminous plants. As compared with the cereals, they are richer in albuminous matter, vegetable fats and mineral salts.

Some pulses and beans contain as much as 18 per cent. or even more of vegetable fat and about 4 per cent. of mineral salts. The salts are richer than those of the cereals in potash and lime, but poorer in phosphoric acid and magnesia. The nitrogenous matter they contain varies from 17 per cent. to as much as 35 per cent. and consists of legumin or vegetable casein. The legumin is generally combined with sulphur and phosphorus, which naturally add to its nutritive value, but render it somewhat difficult of digestion and apt to produce flatus. The starch (or carbohydrates) is comparatively less than in cereals, averaging about 56 per cent. In India these pulses are generally eaten with rice and form the staple diet of Hindus. The pulses are first denuded of their seed coats or skins, and prepared in various ways ; either parched and ground into meal and prepared into curries, or split and boiled with condiments, or ground into flour and made into confectionery.

A few of the important pulses used as food in India will now be briefly described.

(1) The groundnut or peanut ; the seed or Arachis Hypogaea, sub-order Papilionaceæ. The seeds grow in pods partially buried in the ground, hence called groundnuts. Each pod is about 1 to 1½ inches long and may contain 2 or 3 seeds. Its nutrient ratio is 1 : 5·4 and contains 25 per cent. of albuminoids and as much as 50 per cent. of vegetable oils. The nutrient value is 151. Oil pressed from the seed is *bhoiseng* oil. It is used for culinary purposes

instead of ghee and is used also as an adulterant of ghee. The split seeds are fried and mixed with molasses or *ghur* or jaggery, pressed into small squares and eaten. The cake, after the oil is expressed, is used as cattle food.

(2) Gram or chick-pea, the seed of Cicer Arietinum, sub-order Papilionaceæ. Common gram is cultivated almost all over India, but chiefly in the north. The seed is collected and dried in the sun. The unhusked seed is used as horse and cattle food. Gram parched and unhusked is largely consumed by the labouring classes. The nutrient ratio is 1 : 3·3. The percentage of albuminoids is about 19, starch 53 and oil 4·5. The nutrient value is 84.

(3) *Kesari* or *Teora* or *Tuwar Dhal* is a vetch, the seed of Lathyrus Sativa, sub-order Papilionaceæ. *Kesari Dhal* is consumed by all classes but specially by the agricultural classes. The nutrient ratio of the *dhal* is 1 : 1·75. It contains albuminoids 32 and starch 54 per cent. and a very small percentage of vegetable oil. The nutrient value is 87. Occasionally a bitter poisonous principle is present rendering it unwholesome and is said to be the cause of the disease known as Lathyrism. The *dhal* is boiled with spices and condiments and prepared into a thickish paste or curry and is consumed with *chappatties* or rice.

(4) The garden pea of Pisum Sativum and (5) the Lentil of Lens Esculenta (Indian *Mussoor*) may be treated together. The pea is consumed as food when it is green—not ripened, and the lentil, which is regarded as a pulse of inferior quality, is eaten after the husk is removed. The lentils contain a bitter principle which is removed by soaking them in cold water, to which some soda carbonate is added. The nutrient ratio of each is about 1 to 2·5 and albuminoids about 25 per cent., starch about 58 per cent. and oil 1·5. The nutrient value is about 85.

(5) The Soy or Soja bean is the seed of Glycine Soja, sub-order Papilionaceæ. This bean is largely consumed in China and Japan ; of all the pulses or beans, the composition of Soja bean is the richest in albuminoids and vegetable oils, the percentage being 35 and 19 respectively. The nutrient

ratio is 1 : 2. It is rich also in mineral salts, chiefly phosphates and potash. The nutrient value is 105.

(6) *Mung* bean is the seed of Phaseolus Mungo. There are three varieties : P. Manx producing the black, P. Aureus the yellow, P. Mungo the green. The pods of these plants are about 2 inches in length, containing about a dozen seeds. The nutrient ratio is 1 : 2·5, albuminoids 22 per cent. and fats 2 per cent.; the nutrient value is 83. This bean is largely indulged in by the affluent classes and has the reputation among Indians of being easily digestible, and is therefore eaten during illness and convalescence. It is taken in the shape of *Mung khichri,* a dish prepared by boiling *mung,* rice, ghee and condiments in water to a certain consistency.

(7) The Lab-lab bean : this lentil is the produce of Dolichos Lab-lab, sub-order Phaseolæ. The plant is a native of India and cultivated all over the land ; the pod is about 2 inches long and contains about 4 seeds. Both the green pods and the ripe seeds are largely used by all vegetarians. The nutrient ratio is 1 : 2·5 and contains a large percentage of albuminoids (20 per cent.) and of fat 2 per cent. The nutrient value is 80. There are many varieties of this plant, and the beans may be large or small according to the size of the pod. Of the numerous forms of Lab-lab almost all are eaten as green vegetables.

Cereals and pulses are collected in crops. They should, therefore, be carefully sifted, and stored in clean bags in properly paved and dry godowns or granaries. If not properly attended to, they are liable to be rendered unwholesome by damp. They may become mouldy, and ferment and decompose. Grain in this condition is positively dangerous, and, if consumed, produces symptoms of severe gastro-intestinal irritation, causing violent vomiting and purging and even death. All such grain, therefore, should be condemned. Large consignments of damaged, mouldy, wet and fermenting Rangoon rice have been, on several occasions, seized by the Health Department of Bombay under Section 415 of the City of Bombay Municipal Act. The object was to prevent its entrance and sale in local bazaars, so that the same may not be used for human consumption.

Certain cereals are affected by specific fungi. Rye is ergotised by the micelium of the fungus (Claviceps Purpuræ) Secale Cornutum. The ergots if not carefully sifted and removed, but ground into a flour with rye and made into bread and eaten, give rise to a disease called "Ergotism." The initial symptoms generally are vomitting and Diarrhœa, followed by either gangrene of the extremities or convulsive fits.

Wheat is liable to be attacked by a parasitic fungus, the Ustilago Carbo, producing "caries" or "smut" of the wheat. When wheat is ground into flour with smut, it gives a disagreeable odour and the bread becomes of bluish colour; if eaten it causes Diarrhœa. The presence of acarus farina indicates the flour is about to change, and if vibrions are discovered the flour is fermenting and therefore unwholesome.

Occasionally wheat flour is adulterated by an admixture of rye flour and, as rye grain is often ergotised, the use of such flour in bread may cause symptoms of Ergotism. Wheat flour may also be adulterated by the addition of the flour of Darnel seeds or Lolium Temulentum and of the flour of purple cow-wheat or Melampyram Arvense. The latter gives bread a bluish, violet tint but causes no piosonous or injurious symptoms. The addition of flour of Darnel seeds does not impart any colour to the bread but is decidedly poisonous, producing Vertigo, hallucinations, delirium and other narcotic symptoms. The Lolium flour is readily detected by the addition of alcohol, which gives it a greenish hue with a bitterish repulsive taste, and, on evaporation, leaves a resinoid extract of a very unpleasant taste; with pure wheat flour, alcohol gives a straw coloured solution with agreeable taste. Two alkaloids have been isolated from the Darnel seeds; loliine and temuline produced by a parasitic fungus. Loliine is a digestive irritant, while temuline is toxic—a nerve poison.

Beri-Beri is a disease most prevalent in countries where rice is the staple diet. It is endemic in the Malay Peninsula, Indian Archipelago, in China and Japan and on the coast of Brazil. In former years it used to be very prevalent in India, Ceylon and Burma. There exist a few endemic areas near the Masulipatam coast; the incidence of this disease in Indian population generally is very small. It is no doubt true, from its geographical distribution, that it is the rice-eating population which is most affected. So far as rice-eaters are concerned, two theories have been put forward: (1) *The nitrogen starvation theory.*—Baron Takaki (Japan) was the first to propound this theory. Rice consists practically of carbohydrates (starch) 78·3 per cent.; it is very deficient in albuminoids (nitrogenous matter), containing only 7·3 and giving a nutrient ratio of 1: 10·8. This deficiency in nitrogen is said to be the cause of Beri-Beri. To prove this hypothesis and believing his views to be correct, Baron Takaki brought about dietetic changes in the Japanese navy where Beri-Beri was most prevalent. To supplant the deficient nitrogen, he substituted, for a portion of rice eliminated, such foods as were rich in albuminoids—in some instances meat, in others wheat, etc.—and also at the same time improved the conditions the navy lived in. In the brief interval of three years, the disease disappeared. It is contended, however, that this deficiency in nitrogen alone cannot *per se* be the cause of Beri-Beri, as nitrogen starvation is common in all countries among the poorer classes and yet Beri-Beri is limited in its distribution. In Japan Beri-Beri is prevalent more among the middle classes, while in the Malayan Peninsula the poorer classes are affected most frequently. It is necessary to note that the total percentage of albuminoids in rice is about 7 per cent.; but even this very small percentage may be further reduced in the process of decortication and hulling, or may be attacked and absorbed by a fungus.

(2) W. Leonard Braddon, in his treatise on Beri-Beri, expresses the opinion that the disease is produced by "grain intoxication" and rice is the cereal involved. He says "wherever the disease occurs in the East, there is the rice habit" and "not indeed every native in the East is a rice

eater, but every Beri-Beric in the East is a rice eater." The converse of this proposition is also true, *e.g.*, persons who do not eat rice do not get Beri-Beri. His inference is that there is some connection between rice and Beri-Beri and he is of opinion that it is due to the formation of a stable poison in the rice seed. As rice grows in low flats, there abound in such fields microscopic flora—parasites, moulds, fungi, bacteria, mildews and rusts—which from time to time appear visibly and spread over and destroy whole crops. "It is not inconceivable therefore, it is indeed probable," Braddon says, "that some growth, a parasite or merely an epiphyte, itself poisonous or poison-producing, should occur and spread among the grain, which invisible to or at least not yet identified by the eye, imperceptible even to taste, should yet be recognised by that finest of all tests, and for our purposes the crucial one—its effects upon the human economy." He believes such a parasite, sporulating in the soil, is carried by the winds or even by the water to the investing husk of the cereal, to which it attaches itself and subsequently penetrates and lives in it. Dislodged from there during the process of unhusking, it becomes mingled inseparably with rice and is consumed with it. Further, being parasite in its first situation on the husk, it might survive upon the separated seeds, invading them as a saprophyte under conditions of moisture, warmth and darkness in places where rice is stored. He is of opinion that the growth is exactly similar to that of the ergot of rye, or to the poisonous condition produced by a fungus in maize which is said to be the cause of the disease known as Pellagra.

Rice, as has been previously described, is prepared for commerce either "cured" or "uncured." In the former process, the unhusked paddy is boiled until the husk splits, after which the boiled grain is exposed to air until it is perfectly dried, and is finally stored for being unhusked when required, or is unhusked forthwith, and the hulled rice collected in dry clean bags and kept ready for sale or stored in dry, clean, well ventilated godowns for export. This boiling process obtains in respect to Bengal rice and rice grown along the Konkan and Malabar coasts and the rice subjected to it is called " cured rice." "Uncured rice" is milled and hulled after collection and sorting of the crop. This process is adopted in Burma (whence " Rangoon rice "), in French Indo-China and Siam. The uncured rice is further subdivided according to the quality and size of the seed.

Braddon asserts that only one sort of rice, the uncured, becomes toxic and is the cause of Beri-Beri ; experiments made on an extensive scale in Straits Settlements have proved the correctness of his assertion. There are two classes of emigrants in the Settlements—the Chinese and the Tamils. The former are all young adults of good physique, while the latter of weaker physique ; the former who ate uncured rice suffered most from Beri-Beri, while the Tamils. though sickly and of inferior physique, partaking solely of cured rice escaped, but when fed on uncured rice suffered from the disease. Experiments in institutions also proved the correctness of the hypothesis and when the conditions were reversed the incidence of the disease was also reversed ; and, further, the incidence of the disease varied with the sort of grain eaten during an epidemic ; and in localities where it was endemic, the incidence depended upon the *quality* of uncured rice consumed ; if the rice per individual was substituted by other articles of food such as bread, meat, etc., and the quantity of uncured rice reduced, the incidence of the disease fell and ultimately disappeared.

Among the Malays fresh decorticated rice is eaten and there occur no cases of Beri-Beri, but if for any reason the fresh rice is stored and subsequently taken, it may be infected and may produce Beri-Beri. Therefore the only deduction is, that the freshly decorticated rice becomes infected subsequently by some adventitious fungus or mould. In the process of decortication the seed for practical purposes perishes and therefore forms a suitable medium for the growth of a parasite or a saprophyte. But cured rice, obtained after the cereal with husk is boiled, dried and hulled, remains " innocuous indefinitely against the agent (germ) of Beri-Beri although it may be rendered unwholesome so as to cause other diseases, such as Diarrhœa, Dyspepsia, etc. That this is so, rests on the "experience of thousands of Tamil coolies who, though dwelling for a continuous series of years in a region throughout which Beri-Beri has been continuously endemic, even at centres where it has been pestilentially epidemic, and living fellow to others who have acquired the disease beside them, have remained uniformly exempt from the malady while using for their food only cured rice but have succumbed equally with others when dieted on rice of other descriptions"—Braddon (page 374). This fact explains that either (1) cured rice is rendered by the process of curing incapable of serving as a medium for the formation of the specific Beri-Beri poison, or, in other words, for the growth of the agent which secretes the poison, or (2) this specific agent is destroyed by this process. "Since boiling destroys the capacity of rice to undergo the specific Beri-Beri change," Braddon infers, is that the final factor upon which the formation of Beri-Beri poison in rice depends is the presence in raw 'padi,' or in rice freshly made from such 'padi,' of some ferment or living organism which boiling destroys." If the poison produced was on the surface of the seed, as rice is washed before cooking it would be washed away; therefore the inference is that the poison is inside the seed and, therefore, also *non-volatile* and that it is of an alkaloidal nature not unlike ptomaine, a toxin which is stable in character. No such alkaloid has yet been isolated.

Pellagra.—The causation of the disease known as Pellagra is attributed to maize or Indian corn. Some authorities are of opinion that the disease is caused by maize owing, first, to its low nutritive value; secondly, to a toxin or poison inherently present in the normal grain; and thirdly, that maize produces an auto-infection in the intestines by the aid of Bacillus coli communis. De Giaxa cultivated B. coli communis in maize media, and inoculated the toxin produced in animals; the resulting symptoms resembled those of Pellagra. It is popularly believed that maize stored in damp places becomes mouldy, damaged and unwholesome, and consumption of such maize gives rise to Pellagra. It is believed that the fungi attacking maize produce a toxin which is the cause of Pellagra. Other scientists contend that certain bacilli grown in maize produce toxins which cause Pellagra. Prof. Lombroso isolated from fermenting maize two alkaloids : one whose action was like that of *conium*, and the other acted like *strychnine*, but the symptoms produced by these alkaloids on men and animals were not like those of Pellagra. Dr. Sambon discards all these theories and from investigations made comes to the conclusion that Pellagra is caused, not unlike Malaria, by a protozoon which he found in the brain and spinal cord of a person who had died of an acute attack of Pellagra ; and not unlike Malaria, which is conveyed to man by the Anopheles mosquito, the Pellagra poison, he has discovered, is carried to man by a blood-sucking fly of the species of Simulidae (sand flies) the larvæ of which grow in running water or streams. Pellagra, he asserts, attacks almost exclusively the field-labourer and generally those belonging to the poor migratory class. The sand flies (Simulidae) abound in several districts in India. Simulidium Indicum is found chiefly in Northern India and Assam. The female fly is the blood-sucker and the active poison carrier.

Lathyrism is a paralytic affection resulting from the eating of a vetch (*dhal*) of Lathyrus Sativus (*Kesari* or *Tuwar*). In India, in the Central Provinces, there occurred several epidemics. There are several species of this plant. Lathyrus Sativus is indigenous in India, while Z. Cicera (red vetch), L. Chymenum (Spanish vetch) and L. Tuberosus are also regarded as causing this disease. Epidemics have also occurred in Europe. It is said the disease is due to lathyrin, an alkaloid found in this vetch, but this has not yet been experimentally proved. In India the disease chiefly affects the male population, specially cultivators and labourers. *Teora* or *Tuwar dhal* is largely cultivated in the Central Provinces, and also largely consumed. Major A. Buchanan describes the manifestations of this disease. They may be of a purely nervous character attended by cramps or a sensation of pin and needles in the lower extremities and popularly called "Jin-jinny," or the condition of muscles and of the tendons may be in a state of tension (*nuss* *kenchna*) or rigidity. In fact the symptoms are generally of Spastic Paraplegia. Lathyrism occurs chiefly in those districts in which wheat is grown with Lathyrus Sativus (*Tuwar* or *Kesari*) and the percentage of cases increase in districts where wheat crops fail while the *tuwar* crops flourish. *Tuwar dhal* grows best in soils where wheat is cultivated ; and when the latter crop fails, the cultivators of necessity have to eat more *tuwar* and hence the greater incidence of disease among the wheat cultivators and labourers on those fields. Lathyrus grown on rice lands rarely produces Lathyrism. The *dhal* grown on wheat land is called *lakh* and on rice land *lakhori*. The seeds of the former are larger, darker in colour. The rice land lathyrus *dhal* is yellow in colour. The *dhal* is eaten in various ways, either boiled or reduced to flour and made into bread. When *dhal* is boiled no Lathyrism follows, but when eaten as bread, sooner or later the disease comes on. Spastic (*dhal*) Paralysis is rare in districts where *dhal* is eaten boiled after the husk (seed coats) is removed ; it happens that the husk is not removed in wheat growing districts, hence some believe the poison is in the husk. Lathyrism affects horses and cattle fed on the mature lenti or its cake, but when cattle are fed on the lathyrus (green, not seasoned) with its leaves produces no Lathyrism. A volatile alkaloid, lathyrin, was isolated by Asher, but he could not perform any experiments ; while others recovered from the seed a resin, which when injected into rabbits produced Tetanic spasms and Paralysis of the posterior limbs ; other scientists are of opinion that unless the seeds are mouldy or decomposed or attacked by some fungus, they are not poisonous at all. All the diseases above referred to caused by seed poisons, *e.g.*, Ergotism, Beri-Beri, Pellagra, or Lathyrism, affect particularly the nervous system, either the peripheral nerves or centrally the spinal cord, the lateral or posterior columns being generally affected ; and the symptoms produced are manifestations of the action of these poisons on particular portions of the cord centrally or peripherally in the nerve terminations.

PARASITES.

There are certain parasites which affect grain, flour, peas, etc. ; these parasites may be divided into two classes, animal and vegetable.

I. *Animal Parasites.*

The *Calandra Granaria* or the corn weevil, is much larger than the flour mite. The insect perforates the shell and abstracts the contents leaving only the outer shell. It attacks the grain while standing. It is chestnut brown in colour and unlike the rice weevil has no power of flight, the elytra being firmly cemented together.

The *Acarus Farinæ* is found in flour which is beginning to change. It can be distinguished from the Acarus scabei, which it somewhat resembles, by the fact that its legs are thick right up to the end while those of the Acarus scabei taper to a thin end.

The *Bruchus Pisi* attacks peas. It is closely allied to the Br. rufimanus which attacks beans. It is the larval forms of these insects which cause the damage. The grubs live in the seeds and as a result the latter may not germinate, or if they do the resulting plants are weakly. The adult Br. pisi is oval, and dark in colour. The four basal joints at the antennæ are red as are also the shanks and tarsi of the two front pairs of legs. The adult beetles lay their eggs on the pea-pods when they are very young. The larva or grub on hatching bores into the pea and finding nourishment developes to its full growth. It then pupates in the pea having first eaten its way to the outer coat, so that when the beetle is mature it has only to break through the thin outer skin.

The *Bruchus Rufimanus* or bean weevil lays its eggs on the very young pods in the fields. The grub bores its way into the bean and there developes. Two, three or more may be found in the same bean. The full-grown grub pupates in the bean and then, in the spring or earlier, the adult beetle emerges. A round hole shows the place of emergence. In beans still containing the beetle, a little round patch on the outer skin marks the place where the beetle lies.

The *Calandra Oryzae* or rice weevil is dark, reddish brown in colour, with four dull reddish spots on the elytra. Its length is about 4 m.m. It attacks all kinds of stored grain, *e.g.*, maize, rice, buckwheat, and it also attacks peas and beans. The female pierces a hole and then lays an egg. There are upwards of four broods in a year. The larvæ hatched from the eggs consume the contents of the grain and then enter into the pupa stage for a few days and finally develope into the insect which leaves the grain. The metamorphosis occupies about one month to six weeks. This weevil is a most destructive insect.

Tylenchus Tritici.—Grain becomes infected by a worm which is really the larval form of a nematode. It is usually seen in grain kept in damp places. The worm causes the grain to become small, short, thick and blackish, and on examination one finds a thick shell filled with a blackish substance.

Preventive and Remedial Measures against Insect Pests in Grain.

(1) The godowns used must be free from these pests before the grain is introduced and all doors and windows should, as far as possible, be made insect-proof. If the godown is already infected, it should be thoroughly fumigated with sulphur dioxide by means of a Clayton apparatus.

(2) No infected grain should be knowingly admitted into a store.

(3) If infected, the grain should be fumigated before introduction. This can be done by using the Clayton apparatus or by using an air-tight bin of known dimensions. Place carbon bisulphide in a shallow dish and lay the whole on the surface of the grain in the bin and close the lid and leave for 24 to 36 hours. The quantity necessary is about 1 to 1½ lbs. for every 1,000 cubic feet capacity of the bin. It must be remembered that carbon bisulphide is inflammable.

(4) The gunny bags in which the grain is packed should from time to time be fumigated to free them from any insects that may exist in them.

II. *Vegetable Parasites.*

(1) *Puccinia Graminis* is a fungus which attacks many varieties of grain causing a condition known as rust. A spore becomes attached to the grain and sends small filaments into the interior. These increase and form a dense network and later small cellules develope which enlarge and become coloured. These cause the cuticle to distend and finally rupture. The fine powder which then appears on the surface gives rise to the name of rust.

Ustilago Segetum or Smut is a common parasite of corn. It attacks all cereals and is characterised by the grains being filled and destroyed by black dusty spores, which, unlike bunt, are quite conspicuous in the undisturbed plant. Further, it is more common in barley and oats. The spores of smut are smaller than those of bunt, and their surface is smooth. In the case both of smut and bunt, infection takes place when the plant is quite young, the fungus pushing up inside the plant as it grows until ultimately the immature seeds are attacked. Among standing corn which is infected, withered heads can be seen, from which, if rubbed or even touched, a fine powder consisting of the spores of the parasite falls off.

The smut fungus in its resting stage is usually sown with the seed and both germinate at the same time. The mycelium of the fungus spreads throughout the tissues of the host but does not produce any malformation until the head begins to form. The best method of prevention is to sterilise the seed before sowing by soaking it in a solution of copper sulphate (one pound in 20 gallons of water) for 12 to 16 hours and then place in a solution of milk of lime (14 pounds of quicklime in 20 gallons of water) for five minutes. Then dry and sow.

Telletia Caries or Uredo Fœtida or Bunt chiefly attacks wheat and is characterised by the grains being filled by a black mass of spores. The external appearance is not altered, or, if at all, only to the extent of a slight darkening. If the affected grain be cut or crushed, a black powder is seen which when rubbed has a greasy feel and emits a fetid smell. Ears that are attacked are lighter than sound ones and therefore stand more erect than the sound ones, and they also remain green longer as the harvest approaches. Frequently, so long as the ears remain undisturbed the black spore masses remain unseen.

Penicillium Glaucum is a common mould of the air. It consists of long threads interlaced to produce a network. The threads branch and some produce spores. This mould. produces a greenish growth on damp flour bread and on cheese and damp grain.

Claviceps Purpurea.—Rye is subject to a disease produced by this fungus, the growth of which causes the grain to enlarge and become black on the surface, but in the interior the grain is somewhat cream coloured. Ergot may be detected in the flour by the microscope by which the mycelium and spores of the fungus are laid bare, and also by chemical means.

Sporisorium Maidis causes a disease in maize which has been alleged to be the active agent in the causation of the disease in man known as Pellagra, but there is reason now to seriously doubt the truth of this assertion.

Aspergillus Glaucus and Mucor are species of other moulds to be found in damp grain.

In India, green vegetables are consumed largely. Some green vegetables are eaten raw, unboiled. The chief of these are salads, water cresses, spring onions, celery, lettuce, small white radishes, red table radishes, tomatoes, cucumbers, etc. They are of special value in diets, because of their antiscorbutic properties,as they contain alkaline salts combined with organic acids, tartaric, malic, etc. Green vegetables must, before eating, be carefully selected and washed. This is very essential, as most vegetables are raised by the *malee*, or vegetable farmer, on soils which may be contaminated with sewage or on soil recently reclaimed by city refuse, or they may have been raised on lands by the side of drains, or again may have been watered by drain water or water otherwise contaminated with fæcal or other matters. Therefore, they may have been contaminated with pathogenic bacteria, and if not properly washed, cleaned, and dressed are known to have caused cases of Cholera, Enteric Fever and Dysentery. Special attention should be paid to the roots and the outer foliage, as these may be impregnated with the ova of *ankylostoma, ascaris lumbricoides,* etc.

Green vegetables are eaten also after being boiled with condiments or prepared into dishes with addition of butter, etc. The vegetables most commonly eaten thus in this country are cabbage, cauliflower, spinach, lady's fingers (*abel moschos Esculentus*), brinjals, white and red gourd, and a variety of *bhajees* prepared from the young shoots and young stems and leaves of various edible plants. The nutritive value of all green vegetables is very low, but they are largely consumed as they are agreeable to the taste and possess antiscorbutic properties.

Fruits : In India there are many fruit-bearing trees. They yield fruits in seasonal crops, or the fruit may be borne perennially. Fruits are relatively expensive, and therefore are consumed only in comparatively small quantities. They are rarely included in the dietary of the poor man, except the mango and jack fruit when there is a plentiful crop. They are valued rather on account of their pleasant flavour and agreeable taste and other properties than for the nourishment they contain. They contain very little protein, about 1 per cent., and fat 5 per cent.; carbohydrates occur in variable but more considerable quantities and generally consist of saccharine matters (sugars).

Ripe tropical fruits are almost all luscious. When they are over-ripe they begin to change, ferment and decay ; in this condition they are highly unwholesome and injurious to health ; large quantities of such fruit, especially mangoes, custard apples and plantains are destroyed annually by the Health Department of Bombay.

Condiments, Spices, etc.

Indian dishes are generally prepared with condiments and spices. The chief object is to season the food and make it more appetizing and to induce a greater flow of alimentary digestive juices in the food by exciting a turgescence of the blood vessels of the stomach. They have no direct nutritive functions. The spices are all vegetable products derived from various species of tropical plants. They may consist of the fruit, bark, stem, roots and flowers and are conserved in the dry state. They contain volatile or essential oils and aromatic resinous matters. The oils consist of ethers, aldehydes or terbene hydrocarbons, which give the spices their aroma and pungency. The distinction made between spices and condiments is purely conventional; the following spices are generally used in this country: cloves, cinnamon, coriander, saffron, nutmeg, mace, chillies, jinger, pepper, mustard, turmeric, dill, cardamom, cummin (*zira*) and fenugreek (*meti*).

INSPECTION OF FOOD SUPPLIES

One of the important duties of a Municipality is to provide for the efficient inspection of the public food supply. This can only be done by trained inspectors, who are well acquainted with the appearance of animals and flesh, both normal and diseased, and who are well posted in the sophistries practised by the adulterator.

The Inspector may be called upon to examine a living animal. An animal intended for human consumption should be well nourished, free in its movements, its coat in good condition and free from sores and scabs. The eyes should be bright, the mouth and nostrils moist but yet free from discharge. The breathing should be quiet and regular and the breath without odour. The pulse should be regular, and there should be no shivering or indication of pain. When the animal is sick, the coat is rough, the nostrils are dry or covered with foam or discharging profusely, the eyes dull, the tongue protruding, respirations laboured, and the animal's movements are sluggish. The weights of animals vary considerably, and in general the Indian animal is lighter than the corresponding English animal.

	Indian.			*English.*		
	lbs.		lbs.	lbs.		lbs.
Ox	350	to	400	600	to	1,200
Cow	200	,,	300	700	,,	740
Bullock	150	,,	225	300	,,	450
Buffalo	500	,,	700			
Sheep	20	,,	35	60	,,	90

The age of an animal is usually reckoned by the teeth mainly, but, just as in the human subject, there is considerable variation in the time of appearance of the permanent teeth. The range usually lies somewhere within the limits shown in the two tables appended. ;—

BOVINES.

Teeth	Age in years.
2	1½ to 2
4	2½ ,, 3
6	3½ ,, 4
8	4½ ,, 5

SHEEP.

Teeth	Age in years.
2	1
4	2
6	3
8	4

In young animals the cartilages covering the articular surfaces are blue or rosy ; as age advances, however, they become whiter. Up to three years of age, one can cut through the ischio-pubic symphysis, and up to four years through the costal cartilage of the ninth rib. At the age of six this is almost impossible. In young animals the bones are small, soft and porous and have a pinkish colour ; in older animals they become larger, harder and less porous, and of a whiter colour. The beef is light red in young animals, firm and elastic in consistency, and marbled with fat.

In order to distinguish the sex of an animal the following points may be noted. Owing to greater muscular development, the flesh of the bull has less fat than that of the cow. There is great development of the neck, shoulders and hind quarters. The flesh is coarser in fibre, and there is an absence of that marbling seen in cow's flesh. The flesh is dark red in colour, the muscles tough and cross-grained and the carcass is generally poor in fat. Situated at the root of the penis, which in dressed meat is usually found on the left hand side of the hind quarter, is a muscle, the erector penis; this muscle is much more developed in the bull than in the bullock, as is also the case with the penis itself. In the bullock the quarters are less developed, the penis and retractor penis are less prominent, and the erector penis is almost atrophied. The scrotal fat is prominent. The anterior part of the ischio-pubic symphysis is very well developed. If the penis has been removed, a furrow corresponding to its position will be found. The joints of a bull are larger than those of a cow, and the neck is very thick compared with that of a cow, ox or heifer. In the cow the quarters are less rounded, the angles of the haunch are prominent, the anterior part of the ischio-pubic symphysis is ill-developed. The udder is present, or if not, then marks of it are left. The fat at the base of the udder is fairly well developed and the super-mammary lymph glands are large. In the heifer the mammary gland is poorly developed and is surrounded by fatty tissue.

How to distinguish flesh of one animal from that of another. A Meat Inspector must be prepared to detect the substitution of the flesh of one animal for that of another. Horse flesh is frequently substituted for that of the cow, and a knowledge of the following points may assist in the detection of the fraud. Horse flesh is much darker and coarser in fibre, and it is without the small layers of fat seen in the muscles (marbling). It has a disagreeable odour, the fat is oily, yellow and soft due to the large quantity of olein in it. The horse's liver has three lobes and no gall bladder ; that of the cow consists of one large lobe plus a small supernumerary one. The kidney of the cow is lobulated on the surface, whereas the horse's is smooth and not lobulated. The two kidneys of the horse differ in shape, however, that on the right being somewhat heart-shaped, whereas the left one is ordinarily reniform in appearance. The heart of the horse has two grooves on the surface, the fat is yellow and oily, and is but little seen on the surface. The heart of the cow has three grooves, and at its base has a bone not seen in the heart of the horse. The horse's tongue is much smoother than that of the cow. It is spatula-shaped, and the circumvallate papillæ at the base are situated centrally, whereas in the ox the tongue is comparatively pointed with many papillæ at the tip causing a sensation of roughness when the hand is passed over it, and the circumvallate papillæ are situated at the edges, and not centrally. The horse has a longer neck, the bones of the cervical region being elongated, so also the bones of the limbs. The epiglottis of the horse is smaller and more pointed. The horse's sternum is cariniform in shape. The horse has 18 pairs of ribs, the ox only 13 pairs. Moreover the ribs of the former are much narrower. In general the bones of the horse are much heavier. Substitution of the flesh of the goat for that of the sheep sometimes occurs. Both animals have 13 pairs of ribs. The flesh of the sheep is paler and finer, the fat is firm, white and evenly distributed over the back and sides, and the flesh is rarely marbled. The flesh of the goat is dark and possesses a peculiar smell, especially if old. In the sheep the external covering of fat is well developed, in the goat it is practically absent. The neck, body and quarter of the goat are longer. The sheep's liver,like that of the ox, consists of one large lobe plus a small supernumerary one situated on its superior and posterior surface. The normal liver of the goat weighs 8 to 10 ounces. It is divided into two lobes, the larger of which is again divided interiorly by a cleft. The breadth varies from 6 inches to 7 inches and the length from base to apex is 7 inches to 8 inches. The small lobe measures about 2 inches in length by 1½ inches in breadth.

The flesh of the pig is paler than that of either the ox or the goat, and is less firm to the touch. The subcutaneous fat is very white and soft. The pig has 14 pairs of ribs. Its liver has five lobes and the kidney is smooth, elongated and flattened so as to somewhat resemble a broad ribbon.

The flesh of the calf is pale red in colour and not of a firm consistence, and the fat resembles tallow. Slink veal has a gelatinous watery appearance.

Buffalo Meat.—The flesh is pale red in colour, the muscle fibres are coarser and looser than in the ox, and the muscular parts are larger. The fat is pure white. The flesh, when cooked, assumes a darker colour and increases in bulk. The dog's liver is two-lobed and its kidneys are smooth and oblong.

In examining any carcass, the Inspector must pay attention to the following points :—

(1) The colour and transparency of the meat, the smell, consistency and chemical reaction, and the presence or absence of any moisture ;

(2) the amount, character and distribution of the fat, the appearance of the lymphatic glands, serous membranes, articulations and bones ; and

(3) the presence or absence of any signs of lesions or parasites.

Good meat should have the following characteristics.—The carcass should be well set as soon as it is cold : the flesh firm but not tough. It should be well bled and no part of it purple or speckled. When pressed with the finger, the flesh should not pit, as pitting would indicate the presence of watery fluid, nor should it crackle, thereby indicating the presence of air. No pus should exist in the intramuscular tissue. The flesh should be fairly dry after exposure to the air. The meat should have a pleasant odour and be bright red in colour (except in the case of pork, veal and lamb) and should have an acid reaction. The fat should be free from watery juice and blood stains. An excellent test of meat is to insert a clean long thin bladed knife deep into the flesh : in good meat the resistance is equal, and in putrifying meat variable ; on withdrawal the knife should possess no unpleasant smell. There should be no smell of physic about the flesh. In temperate climates the marrow of the hind legs is solid ; about 24 hours after slaughter, it is of a light red colour : if it is brownish or soft, or has black points in it, then the animal has probably been sick or putrefaction is commencing. The quantity of fat varies very much, in an ox it constitutes about one-third, and in a fat pig about half the total. The fat usually solidifies after death. In horses the fat is yellow and oily, and has an unpleasant taste. In oxen it varies from yellow to pale straw colour, in beef the fat consists mainly of palmitates, in mutton of stearates, and in pigs of oleates.

The Inspector should have a good knowledge of the various glands to be examined and their situation. Normally, all the glands are bluish grey in colour, of firm consistency and moist on the surface. The following are some of the more important glands :—

The suprasternal : are found on each side of the upper surface of the sternum.

The prepectoral : are situated at the entrance to the chest beneath the great vessels. One of them is always left just beneath the small muscle, which will be found in front of and attached to the edge of the first rib.

The pre-scapular : are found beneath some muscle and in front of and close to the shoulder joint.

The cervical : lie on each side of the trachea or windpipe.

The brachial : are found under the shoulder blade.

The mediastinal : lie between the two lungs.

The bronchial : lie on each side of the trachea just at its point of bifurcation.

The superficial inguinal (known as the supramammary in the cow) : in male animals are usually found buried in the cod fat ; in female animals they are readily seen when the udder has been removed. It may be here noted that these glands are much larger in the cow than in males.

The deep inguinal or prepubic : is lower down on the brim of the pelvis, 4 or 5 inches removed from the spinal column. It is always embedded in fat. Close to this and under the spinal column is a large collection of glands, the external and internal iliacs and some of the sacral.

The renal : are situated behind the kidney.

The subdorsal : are found in the fat just beneath and attached to the spinal column.

The hepatic : are found between the portal vein and the pancreas; in very fat animals they may be completely buried in adipose tissue.

The popliteal : is found deeply buried in the muscles at the back of the stifle or knee joint.

The precrural: is found on the outside of the hind quarter buried in fat and beneath the muscle in front of and above the stifle.

It is of the utmost importance that the Meat Inspector should examine the glands, especially if the organs have been disposed of. Occasionally, however, the more easily accessible glands have also been removed, leaving only the deeper seated ones, as their removal would necessitate some degree of mutilation of the carcass, thereby lessening its market value. Three sets of glands, however, are practically always overlooked by the butcher, and they afford valuable information to the Inspector. They are (1) the sub-maxillary, which is found on the inner side of the jaw-bone just about its middle. A small tag of muscle, which is almost invariably left in this situation, affords a guide in locating this gland ; (2) the pre-auricular, which as its name indicates, is situated in front of the auricle ; and (3) the post-pharyngeal in the posterior wall of the pharynx. The principal disease for which the Inspector should be on the look-out in glands is Tuberculosis, of which the most usual indication is the presence of soft yellow nodules or areas in the glands.

In cows usually the first organ to be removed is the mammary gland. Both sides of this organ should be of the same size, shape and colour and of the same consistency. The spleen is a solid organ; it should be smooth on the surface and on first being removed bluish grey in colour. It varies from 14 to 18 inches long by 4 inches wide and ½ inch thick normally.

The stomach has four compartments, the first and largest is known as the rumen, the second as the reticulum or honey-comb from its appearance, the third as the manyplus or emasum and the fourth as the obomasum. The external covering of the stomach should be smooth, glistening and bluish grey in colour. The contents should be examined for any sign of drugs.

The covering of the intestines should be smooth and of a uniform grey colour. They lie coiled in a mass of fat—the mesentery. The liver is of a reddish brown colour and of moderately firm consistence and the borders somewhat sharp. In the thicker portions of the liver the borders are more rounded. The organ should contain no lighter coloured or yellow areas. The diaphragm forms a strong musculo-fibrous partition separating the thorax from the abdomen. In its centre it is fibrous and in the periphery muscular. Both surfaces should be quite smooth and glistening and in no part adherent to any organ. The kidneys are solid organs with a lobulated surface and of a uniform brown colour. They are generally concealed from sight in fat. The surface should be quite smooth and glistening. The lungs are soft, elastic and of uniform consistency. They should be of a uniform pink colour, and perfectly smooth on the surface; there should be no yellowish whitish areas in the interior. The tongue has already been described. It should be examined for marks of erosions and the large glands situated at its base examined for signs of Tuberculosis.

Some sources of alteration in the quality of the flesh.

Initial or essential defects including (*a*) *age*: very old or very young animals are not so nutritious as the average adult. An old animal is occasionally very deficient in nutritive value: the fat almost disappears and the muscular tissue in part replaced by fibrous tissue. The flesh of young animals is deficient in salts and fat. (*b*) *Overwork and exhaustion*: The meat loses value as a food and is often unpleasant to the taste; no animal should be slaughtered when in a tired or frightened condition. The flesh is liable to rapid decomposition. (*c*) *Unsuitable feeding*: Certain medicines given to an animal may produce symptoms in the consumer, *e.g.*, antimony, arsenic, lead, strychnine and phosphorus. Occasionally the smell of the medicine can be detected, and this should lead the Inspector to institute inquiries as to the nature of the illness which necessitated the administration of medicine. Ether, turpentine, creosote, carbolic acid and hydrocyanic acid are examples of drug which may impart an odour to the flesh. If an animal has been poisoned by unsuitable food, *e.g.* yew leaves,bryony, meadow saffron, or by mineral poisons purposely given there will usually be some indication to be found in the stomach, more marked in the case of mineral poisons, and certain changes may be found in the liver, *e.g.*, fatty degeneration in the case of arsenic and phosphorus. Animals fed on red cabbage and beet leaves may produce a poisonous milk, which in certain individuals may cause acute Enteritis. (*d*) *Starvation* acts much like old age: the meat wastes considerably in cooking owing to the deficiency of fat. (*e*) The flesh of animals killed by lightning and apoplexy rapid ly decomposes. The organs and flesh are dark in colour, the meat is full of blood and badly set, as is the case also in animals which have been smothered or drowned. If the flesh is full of blood, the carcass should be condemned. In regard to animals injured by accidents, much depends on the nature and extent of the injuries. If the accident is such as to result in purely localised bruising, this portion of the meat only need be condemned and the rest passed provided that the bruising is not too extensive and the animal is slaughtered at once. If, however, the accident results in much bruising and injury to the animal and it is not slaughtered early, the flesh is apt to be dark and ill-bled and should be condemned. The flesh of animals dead from accident is usually dark and the serous membranes stained, owing to the animal not having been bled or only imperfectly so. The flesh of animals slaughtered just before, during, or after parturition need not necessarily be condemned, unless there is evidence of extravasations of blood or of pyæmia and of inflammation of the pelvic organs and membranes. (*f*) The *diseases*, both infectious and non-infectious, which either on the whole or in part render meat unfit for human consumption, or which depreciate its quality and therefore its market-value, ordinarily met with in clude Tuberculosis, Pseudo-Tuberculosis, Actinomycosis, Dysco-mycosis, Anthrax, Rinderpest, Pleuro-Pneumonia, Swine Fever, Sheep-pox, Erysipelas, and worms of various kinds etc., etc.

TUBERCULOSIS.

Tuberculosis is a very wide-spread disease in man and animals. It is very common in cattle and poultry and occur also in dogs, cats and the larger carnivora. In sheep and goats it is comparatively rare, especially in the former. Comparative statistics show that the disease occurs in cattle 16-25 per cent., swine 2-3 per cent. and sheep 2-3 per cent. The horse is also liable. Birds are specially susceptible, the disease causing great mortality in hens, geese, turkeys and pheasants. Most wild animals are susceptible. The disease also occurs in monkeys in confinement and in the the nodules have a special tendency to break down into a pus-like fluid.

The disease may be either local or general. Small oval or spherical nodules form, and these may soften and become caseous or contain pus, while others become fibrous or even calcareous.

Tuberculosis is due to a bacillus discovered by Koch. It belongs to the acid-fast group, which also includes the smegma bacillus. The bacilli are straight or curved, non-motile rods from 2 to 4 mm. in length. They are very difficult to cultivate in the absence of glycerine. They occur scattered in the tissues, or in little round masses. They are usually single, but may sometimes be found lying end to end forming an obtuse angle: true chains are not found. Their resistance is considerable and they can retain their vitality outside the body for a considerable time. Salting and smoking do not kill them. They resist the gastric juice for 6 hours, and a temperature of 3°C for 3 hours and drying and putrefaction for a very long time, even months.

In *cattle,* generally the lungs are affected, nodules appear in them and these may be firm, caseous or calcified. In addition one may find caseous Pneumonia and small Tubercular granulations. Along with these changes in the lungs, there may be nodules on the pleura and peritoneum, some of which may be pedunculated. In other cases, however, the abdominal organs may be primarily affected. The udder becomes diseased in about 3 per cent. of cases, but primary affection of the gland is rare.

In *pigs,* as a rule, the disease is abdominal in origin, the liver, spleen and glands being affected. In other cases a caseous Pneumonia is found and in other instances again the organism produces a chronic affection of the lymphatic glands, known as Pig's Scrofula. Tubercular affections of the muscles are less rare in pigs.

In *the horse,* the abdominal organs are the primary seat of the disease, the spleen being enormously enlarged and crowded with nodules. Occasionally the primary lesions are pulmonary. The mesenteric glands become enlarged. The disease may spread to the lungs, causing miliary Tuberculosis. In the cow, on the contrary, the disease generally commences in the lung with a local tubercle, later the pleura are affected causing grapes and, later on, there may be a small amount of miliary tubercle.

Action on the tissues.—The local lesion is a Tubercular nodule of a central giant cell which has many nuclei, often in a ring towards the periphery, but sometimes in a clump at one end. Round this are spindle-shaped epithelial cells, and round these uninucleated leucocytes. Giant cells are found especially where the caseous change is relatively not active. Caseation, softening, calcification or fibrous changes may occur. The general action is to produce Pyrexia, perspiration, wasting and waxy degeneration.

In cattle the organism is very often found in the giant cells, and scattered irregularly through the cellular connective tissue elements of the lesion, if little or no caseation is present.

In the horse and in birds one may see enormous numbers, even though the lesion be not very acute.

Paths of infection.—(1) Air passages ; (2) alimentry canal ; (3) wounds in the skin ; and (4) the genital organs, but this method is very rare. If infection is *via* the alimentry canal, the disease usually commences in the pharynx or small intestine.

To detect tubercle in carcasses.—It is necessary to examine most carefully the following portions of the carcass :—(1) The pleura and peritoneum for grapes, which present the appearance of nodules of varying size on these serous membranes. If either the pleura or peritoneum in part or whole is missing, the carcass should be rejected. (2) The various organs, *e.g.*, the liver, spleen and kidneys for the presence of tubercles or small nodules ; and if these organs are missing, then examine the glands (this should be done in all cases). (3) The glands to be examined have already been referred to in detail, but special attention should be paid to the post-pharyngeal, because they are often early infected, and to the sub-maxillary and pre-auricular because these are often overlooked by the butcher, who may remove some of the more prominent and more easily accessible glands. If on examining a carcass, it is found that the organs have been disposed of and the glands removed and the pleura stripped from the ribs and the diaphragm removed, it is almost certain that the carcass was Tuberculous, and it should be condemned. Stripping of the pleura *per se* cannot always be held to be indicative of an attempt to hide evidence of Tuberculosis, as it may have been removed as the result of staining, owing to oversticking in the course of slaughter. This staining spoils the appearance. The glands should be most carefully examined before passing as fit for food any animal which has had its pleura stripped for such an alleged cause.

The question of the suitability for human consumption of an animal suffering from Tuberculosis is at present almost entirely determined on the lines of the recommendations of the Royal Commission, appointed to report on this question. They advised that the entire carcass should be seized, when—

(1) there was miliary tubercle of both lungs ;

(2) Tubercular lesions were present in the pleura or peritoneum ;

(3) Tubercular lesions were present in the muscular system, or in the lymphatic glands lying in or between the muscles ;

(4) Tubercular lesions were present in any part of an emaciated carcass ;

and that the affected organs or parts containing lesions be condemned when the lesion was confined —

(1) to the lungs and thoracic lymphatic glands ;

(2) to the liver;

(3) to the pharyngeal lymphatic glands;

(4) and to any combination of the above when collectively small in extent.

In the case of the pig, if Tuberculosis is present in any degree, the carcass should be condemned.

Experimental Inoculation.—If a guineapig be inoculated in the leg, in 9 or 10 days the popliteal and superficial inguinal glands on the same side will be enlarged; in 14 days the deep inguinal and lumbar will also. In 21 days the retro-hepatic and splenic glands are enlarged and the spleen and liver show small nodules. Later on, it is difficult to say which side was inoculated and the difficulty increases the further forward one goes. If the guineapig be inoculated in the peritoneal cavity. the first gland to become enlarged is the retro-peritoneal near the junction of the mesentery and the abdominal wall, next the retro-hepatic and then the post sternal.

PSEUDO-TUBERCULOSIS.

As the name implies this disease is occasionally mistaken for Tuberculosis. It is seen frequently in sheep and affects cattle and swine also. It is due to the presence of certain forms of strongyli; other varieties are seen in rabbits and cats. Sheep are affected with the Strongylus filaria and rufescens; cattle with the Strongylus micrurus, especially young cattle, and swine with the Strongylus paradoxus.

The strongyli cause lesions in the lungs, and are liable to be mistaken for Tuberculosis. It must be remembered that this disease is rare in sheep (·2 to ·3 per cent.). The strongyli are filiform bodies with lobed tails occasionally. They live in the bronchi, and the female travels to the terminal alveoli, and there lays her eggs. These eggs may undergo development and set free larvæ which may cause irritation in various parts of the lung, or the young may cause a localised inflammation. As a result of the irritation caused by the eggs or the larvæ, Bronchitis or diffuse Pneumonia may arise, and, in addition, small nodules form and it is these nodules that are liable to be mistaken for true Tuberculosis.

Structure of a nodule.—In the centre one may see an egg containing an embryo, or a free embryo may be seen, or yet again, only a degenerated mass may exist. There is considerable small-celled infiltration of the alveolar walls and an accumulation of corpuscles in the alveoli involved. At a later stage, fibrous tissues form in the alveolar wall. In the neighbourhood of the worm itself, one may see degeneration simulating a fibrous capsule. Occasionally calcification occurs in the nodule. It is very rare to see a giant cell in these nodules.

Mode of spread.—All the year round numerous free embryos are found in the mucus in the air passages. In England they are specially numerous in March and September. They escape from the animal with the mucus and live on the moist ground for a very considerable time. They can resist drying for a long period. They are probably taken up in the food. Their life history is not accurately known and it is a matter for conjecture whether from the stomach they bore a way to the lungs, or whether, *via* the œsophagus, they creep to the larynx and thence to the lungs. The disease is not communicable to man.

Appearance of the lungs.--The lung appears firmer than usual. The surface presents a blotched appearance. Some parts are brown white, others are pink or pale pink in colour. Nodules of a yellowish white colour are seen on the surface and also in the substance of the lung ; they are of firm consistence and vary in size from a pin's head to an ordinary marble. Only the very bad ones need be seized.

ACTINOMYCOSIS.

Actinomycosis affects man, oxen, horse, sheep, pigs and dogs. It is most common in cattle. It is sometimes seen in sheep and pigs, occasionally in the horse and dog, and more rarely in man, resulting from direct injury from the spikes of barley and not from infected meat.

In man and the pig the disease is characterised by chronic suppurative processes, which often extend to internal organs producing a chronic Pyæmia. In the ox and horse it is characterised by abundant formation of granular tissue resulting in tumours, especially on the tongue in cattle.

The disease is due to a parasite which grows in the form of little round masses about the size of a small pin's head. When suppuration is present, they lie free in the pus and when suppuration is absent they lie imbedded in the granulating tissue. They may be transparent or jelly-like, opaque, or may appear as white, yellow, green or black according to age.

When examined under a microscope, these small masses are seen to be composed of three elements : (1) comparatively thin filaments, often of great length, between which is a fine granular substance ; (2) coccus-like bodies formed by segmentation of the filaments ; and (3) club-shaped bodies formed by a hyaline swelling of the sheath at the end of a filament.

In the human being it produces chronic inflammatory changes usually ending in suppuration, which spreads slowly and is usually associated with an abundant growth of the organism in the filamentous form. Multiple foci of suppuration are seen at the spreading margin.

In cattle the disease assumes more of a formative type, resulting in abundant growth of granular tissue forming tumours more or less nodulated. It is rarely seen to a greater extent than 1 or 2 per 1,000 in England. It affects the tongue, lower jaw, lungs, tonsils, liver and intestines, etc.

The tongue becomes large and very hard, due to a great accumulation of fibrous tissue under the mucous membrane, especially in the back and sides. The jaw becomes enlarged, bulged out and nodulated ; when cut across, dense bony tissue is seen with spaces containing soft purulent granulation tissue, occasionally a cavity filled with pus is found, or nodules with a mulberry-like spot in the centre.

There is, as yet, no evidence that man is directly infected with the disease from animals, but nevertheless any animal infected with Actinomycosis should be condemned as human food. This is the rule in most of the American States and in England.

BOTRYOMYCOSIS OR DYSCOMYCOSIS.

Botryomycosis or Dyscomycosis is a disease very rare in man, common in the horse, less so in cattle. It is a chronic disease resulting in the formation of large masses of fibrous tissue in various parts of the body. These masses enclose small purulent foci and may cause fistulous openings just as in Actinomycosis. On microscopical examination, instead of the typical Actinomycosis in small lobuli, one finds clumps of small cocci in rounded masses of from 50 to 100 m.m. in diameter, each mass being surrounded by a zone of hyaline matter, and containing small yellow granules. Each mass is held together by fibrous tissue. The disease is due to a coccus—the Botryomycosis Equi. Grown on potato, it produces a bright orange colour like the staphylococcus pyogenes aureus, but differs in causing a smell of fresh strawberries. There is no evidence that the flesh is capable of producing the disease in man, in whom the disease is very rare. Cattle and the pig suffer but rarely. The sheep, goat, dog, rabbit, guinea-pig and mice may suffer possibly. In the horse, the skin, subcutaneous tissue and the fibrous tissue of the spermatic cord may be affected. In the ox, the udder and viscera are occasionally attacked.

ANTHRAX.

Anthrax is a disease which occasionally occurs epidemically among herbivora, especially oxen and sheep. The horse, deer and goat are less susceptible. Rabbits, guinea-pigs and mice are very susceptible. Pigs are sometimes attacked. The white rat, adult carnivora, birds and amphibia and Algerian sheep are not susceptible; the brown rat is. The disease is readily contracted by man. Anthrax is a very common disease in India, Persia and Siberia. It is due to a large non-motile, spore-bearing bacillus, which has a comparatively low power of resistance, being unable to stand exposure to 60° for long. If kept dry at ordinary temperature, it dies in a few days. It can grow without oxygen, but it grows much better with it. No spores are formed in the absence of free oxygen, and this fact has great value in the question of the disposal of carcasses of animals dead from this disease. Though the organism itself has but low power of resistance, it is quite the reverse with the spores: if kept dry, they will live for a year or more. They resist boiling for five minutes and require a dry heat of 140° for several hours to kill them. They will live in sewage, in the soil and in distilled water for several months. Spore-formation does not occur in the body of a dead animal owing to the absence of free oxygen. Both the bacilli and the contained spores die speedily if kept within the intact carcass. This points to the urgent necessity of preventing the effusion of blood when disposing of a dead carcass. The disease manifests itself in various forms. The worst form is very sudden; it is seen especially in sheep and cattle, and, from its nature, is called fulminant or apoplectic. The animal has sudden loss of appetite, trembling movements, irregular movements, backwards or to one side, dyspnœa, cyanosis, convulsions, ejection of blood by the nose or with the urine and fæces; death occurring in from a few minutes to 4 or 5 hours. Another form is splenic fever or splenic apoplexy. This is especially virulent in oxen and sheep. The animal is excitable and restless, and its temperature rises 3° or 4°. The mucosæ are congested, and in sheep this may show on the finer parts of the skin, *e.g.*, inside the forearm or thigh. There may be tremors, erection of the hairs, dullness, prostration, thirst, grinding of the teeth, colic, passage of mucus and blood per rectum, and discharge of blood from the nose. The blood is very dark and usually has a thick tarry appearance. Death usually supervenes, in sheep in 24 hours, and in cattle in from 2 to 5 days, and in horses 1 to 6 days. In more prolonged cases there is wide spread œdema, extensive enlargement of lymphatic glands, and, in those about the neck especially, necrosis and ulceration may occur. This subacute form is seen more particularly in horses, which are less susceptible than cattle and sheep.

Post-mortem appearance in the Ox.—The spleen is very greatly enlarged, dark red in colour, very soft and friable. The liver is enlarged and congested and shows signs of acute cloudy swelling. The kidneys and lungs are also congested. The heart shows cloudy swelling, and the intestines are congested and filled with a bloody fluid. The glands, especially the mediastinal, mesenteric, and cervical, are much enlarged and surrounded with œdematous tissue ; the lymphatic vessels are also swollen and both the glands and vessels contain bacilli, as also do all the organs especially the spleen. The flesh is darker than usual and is also often dropsical and bile-stained. Putrefaction of the carcass is often rapid. In the very rapidly fatal cases the changes in the blood and tissues may be but little marked, and after removal of the enlarged engorged spleen, and infiltrated internal organs, the carcass is sometimes placed on the market and may pass unnoticed. In more prolonged cases the changes mentioned above have occurred, and there is therefore more liability of detection. The flesh of an animal suffering from Anthrax, in whatever stage, should invariably be condemned. Great care must be exercised in disposing of the carcass to prevent any effusion of blood. The best method of disposal is by cremation of the entire carcass.

Anthrax in the pig is comparatively rare ; when it does occur the body is livid and sodden and darker in colour and the spleen and other organs are affected much as in the case of the ox.

EMPHYSEMATOUS ANTHRAX.

Synonyms.—Symptomatic Anthrax, black quarter, black leg, or quarter ill. An acute infectious disease characterised by hyperthermia, lameness, and a localised, hot, painful swelling on the shoulder, quarter, leg, neck, trunk or elsewhere, tending to emphysema and gangrene, and, when incised, showing black extravasated blood, clotted or frothy. It is due to a rod-shaped microbe with rounded ends found singly or united in pairs or very short filaments. These microbes form spores even in the body of the affected animal. They are motile and anærobic.

Post-mortem appearance.—The carcass is liable to be bloated with gas, and a reddish frothy fluid often escapes from the mouth, nose and anus. Gas is particularly abundant in the neighbourhood of the tumour, which on being incised exposes a mass of extravasated blood and lymph exudate. The muscles beneath are of a dirty brown or black colour and readily break down under pressure of the finger. They are infiltrated with a gas and crepitate on pressure, and in them the bacilli are present in large numbers. The swelling may occur also in the tongue, pharynx, pleura, lungs, heart, mediastinum, pericardium and the peritoneum, etc. The liver and kidneys may be hyperæmic. The spleen is rarely enlarged. The disease is often speedily fatal. The carcass should be cremated without being cut in any way. The meat is entirely unfit for human consumption.

RINDERPEST OR CATTLE PLAGUE.

Rinderpest is a contagious disease indigenous to the Asiatic Steppes of Russia, India, Persia, China, Burma, Tibet and Ceylon. It has a period of incubation varying from 4 to 8 days ; it runs a definite course and frequently terminates fatally. Though bovines are by far the most susceptible, and it is by them that the disease is mainly propagated and in them that the mortality is greatest, infection may be communicated to the sheep, goat, gazelle, deer, camel, giraffe, dromedary and buffalo. The horse, dog, rabbit, birds and man are immune. The earliest symptom is an abrupt rise of temperature (104°F. to 108°F.), usually reaching its maximum on the third or fourth day, falling when other symptoms are developed. In two days the rise of temperature is followed by white eruptions on the inner sides of the lips closely resembling thrush, and there is an alteration in the appearance of the mucous membrane of the vagina. The following day the animal appears definitely ill and its appetite is less. After the fourth day the animal is seriously ill, drooping head, hanging ears, distressed look, rigors and twitchings of the superficial muscles, failing pulse, oppressed breathing, fetid breath, and discharge from mouth, nose and eyes. On the sixth day the pulse becomes feeble and thready and the limbs weak, the temperature begins to fall also, the belly becomes tender, and the preliminary constipation is followed by Diarrhœa with much rumbling. When the disease is fully established, the respirations are often characteristic, consisting of a sudden closure of the glottis, with an audible clicking sound in the course of an expiration, and, after a perceptible interval of holding the breath, the expiration is resumed with or without an accompanying moan. The secretion of milk is arrested, often in a sudden and complete manner. The animal grinds its teeth, arches its back, and draws its legs together. In the mouth in some cases small round nodules, seldom larger than a millet seed, are observed, through which a yellowish material may be seen. In a few hours the epithelium gives way leaving a small superficial ulcer, which however heals rapidly leaving no scar. The vaginal mucous membrane becomes of a deep dark-red colour.

Post-mortem appearance.—The mucous membrane of the mouth, larynx and pharynx, and of the fourth stomach and small intestine are marked with streaks and patches of red and the follicles are reddened. The terminal portion of the rectum is especially liable to marked congestion and blood extravasations with more or less desquamation and erosions. The spleen is normal, in strong contrast to that organ in Anthrax, in which disease similar lesions are found in the intestine, especially the rectum. The liver is usually rather pale and soft. The skin may be yellowish red or dark with a general scurvy condition and eruptions of a rounded wart-like nature on the teat and udders. The blood is at first but little altered, later, however, there is a marked increase of fibrin and a decrease of water ; and before death it becomes black and incoagulable. In the advanced stages the flesh is dark, has a disagreeable odour, and may crackle on pressure. The flesh is considered unfit for human consumption and should always be destroyed.

FOOT AND MOUTH DISEASE.

Foot and Mouth Disease is an acute infectious disease of lower animals, especially ruminants, characterised by a slight fever and the eruption of vesicles or bullae on the skin and mucous membranes and most usually seen on the feet, mouth and teats. Sheep and pigs suffer less often. Man is susceptible, as are horses, dogs, cats and fowls, when they are inoculated or fed upon infected material, *e.g.*, milk or other products.

Symptoms.—The incubation period varies from 36 hours to 5 days, and occasionally longer. There is a rise of temperature (102° F to 103°F), with shivering, dryness and heat of the muzzle, redness of the mucous membrane of the mouth and teats, and impaired appetite, tenderness of the feet and extension backward and shaking of the hind feet in turn. On the second day the eruption usually appears and the fever moderates and bullae may be found on the inside of the lips and cheeks or on the palate and tongue with, in many cases, a congested areola. These vesicles burst leaving a red sore covered with the remains of the vesicle, suppuration may ensue, and, if very severe, abscesses may form in the liver and lungs. On the teats the bullae appear about the same time, but they are usually smaller than the buccal bullae. On the feet eruption shows especially in the interdigital space, and, if exposed to dirt, these ulcers may extend and result in the shedding of the hoof. The Board of Agriculture do not permit infected animals to be brought into public abbatoirs. If the disease is not very severe, the flesh may be passed for food, but the affected parts are not to be used as food.

EPIZOOTIC PLEURO-PNEUMONIA.

Epizootic Pleuro-Pneumonia is an infectious febrile disease occurring in cattle, characterised by a prolonged incubation period, an insidious onset, inflammation of the bronchi, lungs and pleura, and a profuse exudation into the interlobular connective tissue and chest, and a very extensive area of consolidation in the lungs. Several micro-organisms have been assigned as the cause of this disease.

Post-mortem appearance.—If death has occurred early, the lesions are essentially pulmonary, though the pleura and mediastinum may be implicated. The bronchial, mediastinal and prepectoral glands are enlarged. Later, the glands of the pharynx, mesentery and sublumbar region and groin are enlarged and there is hyperæmia and congestion of the intestinal follicles and intermuscular tissue. The lungs show various stages of hepatization. The flesh is dark.

Pleuro-Pneumonia of cattle does not appear to be conveyed to man. In Germany the flesh is allowed to be sold after it has been thoroughly well-cooked and left till perfectly cold. The lungs, however, are to be destroyed in every instance. In the early stages of the disease, the flesh appears to be normal in appearance, colour and consistence, later it becomes emaciated, discoloured and flabby. In England it is customary to condemn only those carcasses which show signs of the disease in the muscular tissue, and to pass the carcass if it presents no departure from natural conditions.

GLANDERS AND FARCY.

Glanders is of importance to the Meat Inspector mainly because of the occasional substitution of horse flesh for that of the ox.

Glanders chiefly affects horses, mules and asses. It is also seen in guinea-pigs and field mice, and in carnivora such as dogs, cats, lions and tigers. It also affects man as the result of inoculation. Cattle, swine, the horse and white mice are immune.

In the horse one may see either Glanders proper, or Farcy which is a different manifestation of the same disease, or both may be seen together. The disease may be acute or chronic. The disease is characterised by a rise of temperature and rigors. The septum nasi and adjacent parts are most affected. The mucous membrane of the nose becomes congested, sometimes only on one side, and later nodules form, which are at first firm and translucent and of a greyish appearance. They are accompanied by a profuse discharge. Later, the nodules soften in the centre and ultimately ulcerate ; several small nodules may coalesce to form one large ulcer with a raised margin. The septum is usually first affected and the turbinate bones may become so later. The lungs may show Broncho-Pneumonia and nodules. The Pneumonia may be more or less general and accompanied by intense hyperæmia. The nodules exist in various parts, especially under the pleura ; they may be very small, but are generally larger than the tubercular nodule ; moreover, they are fewer in number, and do not show the same tendency to coalesce. There is marked hyperæmia around them, Microscopically they are seen to consist of, in the centre, leucocytes, chiefly with much exudation of blood-stained fibrinous lymph in the alveoli, the walls of which are very congested. There are no giant cells. Later, the central part becomes granular and opaque, and around this is a zone of leucocytes and epitheliod cells and perhaps a few giant cells. Associated with these lesions in Glanders proper, there is usually some inflammation of the glands in the neck, and mediastinum, and there may be grey or yellowish nodules in the spleen and liver and orchitis. Dyspnœa, difficult deglutition, Diarrhœa and emaciation are present usually.

Farcy—or Glanders of the Skin—is less common in chronic Glanders than in acute. Small swellings, which are really localised abscesses, form: the usual site being the limbs, flanks, shoulders, breast and neck. The nodules are known as Farcy buds and they vary in size from a pea to a moderate walnut. They cause secondary inflammation of lymph glands and vessels, forming Farcy pipes or cords. Infection occurs through an abrasion of the skin. The affected glands become larger and firm and may at a later stage suppurate and ulcerate. Secondary nodules may occur in the internal organs and on the nasal mucous membrane. Acute Glanders is generally seen in asses, chronic in horses, and both forms in mules.

The disease is due to the Glanders bacillus, which is a minute rod with rounded ends, straight or slightly curved. It is about the same length as the bacillus of Tuberculosis, but is slightly thicker. It is non-mobile, non-sporing and non-retentive of Gram's stain. It is sometimes seen in short filaments. In the tissues it lies scattered irregularly among the cellular elements, mostly extracellular. It is sometimes seen in the leucocytes and connective tissue corpuscles. It is most abundant in acute lesions and may be difficult to find in chronic nodules. It is not killed at once by drying, but is ultimately. It is not easily killed by putrefaction, and it offers but a feeble resistance to heat and antiseptics. Injected into the peritoneum of guinea-pigs, it is followed by a very rapid and semi-purulent affection of the tunica vaginalis in 3 to 4 days, and there are also nodules on the peritoneum. The diagnosis of Glanders is assisted by the inoculation of guinea-pigs and by the injection of mallein into the suspected animal. Mallein is prepared by growing Glanders bacilli on glycerine bouillon, subsequently sterilising and filtering and adding a little carbolic acid (5 per cent.) to prevent decomposition. One c.c. is injected subcutaneously at the base of the horse's neck. The animal's temperature should be taken before injection, and at 6, 10, 14 and 18 hours after. In a Glandered animal, at the site of inoculation a painful local swelling forms, which is at its maximum size in 24 hours (5 inches). The temperature rises 1·5 to 2 degrees and is at its maximum in 8 to 16 hours. If the temperature never rises 1½ degrees, the reaction is doubtful. In negative animals the temperature may rise 1 degree and the swelling may reach 3 inches, but it subsides next day.

The experience of the Siege of Paris in 1870 does not tend to show that any ill-effects were experienced as the result of eating horses which had suffered from Glanders and Farcy.

SHEEP-POX.

Sheep-pox is a contagious and infectious disease analogous to Small-pox and Cow-pox. It prevails among sheep and goats and is characterised by early and marked hyperthermia, followed by the appearance, on the bare or merely hairy portion of the skin, of diffuse redness, a rounded papular eruption passing into vesicles, pustules and scabs which ultimately fall off in 15 to 20 days. There are two main forms: (1) malignant, in which the sheep lose their eyes, the wool falls off, the skin cracks in a zig-zag manner and the nostrils fill with a fetid discharge; and (2) benign, in which a genuine blister forms leaving pits on which the wool never grows again.

Symptoms.—An initial fever followed later by red nodules deeply bedded in the dermis and usually first seen on the inner aspect of the arm and thighs and the cheeks, lips and the undersurface of the tail and round the anus. The animal is usually dull and thirsty, and the eyes bloodshot. The papule developes into a flat vesicle which ultimately becomes turbid, and, forming a crust, is cast off with the epidermis.

The head is held low, the animal lies by itself in a corner with breathing quick and short, and a discharge from the nose. A secondary eruption may occur, but only papules form. The duration is usually about three weeks, but, in cold weather, it may reach four.

Post-mortem appearance.—The body is swollen and exhales a fetid odour. The eye and nose are closed by a dry discharge. The mucous membrane of the mouth, nose, pharynx, œsophagus, larynx, bronchi and of the rumen are covered with large nodules, and occasionally in the larynx there are ulcers. The lymphatic glands in various parts are enlarged and the subcutaneous tissues are engorged with blood. The pleuræ are often congested and there may be petechiæ, exudation and discoloration. The flesh becomes soft and dropsical.

The flesh should be condemned as unfit for human food. Except in the early stages, the flesh has a most disagreeable odour. In the later stages the flesh becomes soft, pale and dropsical.

SWINE ERYSIPELAS.

Swine Erysipelas is a disease of swine characterised by high fever, great prostration and muscular weakness and a violet hue of the visible mucosæ and a red or violet discoloration of the skin in spots or patches, or even universally, and enlarged lymphatic glands and spleen. The disease is due to a bacillus which is found in small numbers only in the blood and vascular system, but in large numbers in the lymphatic glands, spleen, kidneys and red marrow. The incubation period is about 3 to 4 days. The animal shows sign of fever, the respiration and the heart are accelerated, the animal refuses to move; at first there is costiveness, later Diarrhœa. Discoloration of the skin appears early ; it may be red or violet, and is noticed round the root of the ears, neck, breast, the inside of the arms, and thighs, abdomen and perineum. The isolated spots may coalesce and form one large mass on the abdomen or the back. The mortality is very high.

Post-mortem appearance.—There are many extravasations into the skin the lymph glands are enlarged and become dark red or almost black in colour. The liver and spleen are congested, as are also the lungs and kidneys. Rigor mortis is lessened and, if the disease has been of long duration, there is emaciation and Dropsy.

HOG CHOLERA.

Hog Cholera is a contagious disease of swine, of an acute or subacute form, characterised by fever, congestion, exudation, ecchymosis and necrotic ulceration of the intestinal mucous membrane and of the stomach, and by a profuse Diarrhœa, enlargement of the lymphatic glands with congestion and blood extravasations, by effaceable blotches and ineffaceable petechiæ of the skin, snout and visible mucosæ, with a tendency to necrotic changes, and less frequently by pulmonary congestion and degeneration and by a high mortality. The disease is due to an actively motile bacillus mostly occurring in pairs.

Post-mortem appearance.—The spleen is found enlarged, soft and dark.

There is no evidence that the flesh of swine suffering from Hog Cholera causes illness in man. In Germany, the sound flesh of animals infected may be sold with a declaration as to its nature, after thorough cooking. The infected parts must be burned or buried. In England, the disease is considered one which renders the flesh unfit for food.

COCCIDIOSIS.

Coccidiosis is a disease met with in rabbits, sheep and cattle. It is very occasionally seen in man. It is caused by psorosperms. On examination the liver of the affected rabbit is seen to be studded with nodules, which may approach ½ inch in diameter. A common form is the Coccidium Oviforme. It is to be found in the bile ducts, or enclosed in the epithelial cells thereof. If a nodule be opened, clear, ovoid bodies with a capsule of high refraction giving a double contour will be seen. The fæces of affected animals contain these bodies. Somewhat similar forms may be seen in dogs, calves, sheep and birds. Development takes place in the epithelial cells of the liver and bowel.

In so far as suitability for human food is concerned, it is sufficient that the liver and intestines be destroyed.

MALIGNANT ŒDEMA.

Malignant Œdema is an acute disease of domestic and wild animals, characterised by a painful and often crepitating swelling in the vicinity of the affected part. The tissues become swollen and, in the case of an open wound, there is a profuse discharge of a yellow, watery or serous aspect, and bubbles of gas possessing a fetid odour.

The flesh should be destroyed.

RABIES.

Rabies may attack dogs, wolves, foxes, jackals, cats, lions, tigers, pigs, horses, cattle, sheep, goats, deer, rats, mice, chickens and pigeons.

The flesh of edible animals should be destroyed.

ACUTE RHEUMATISM OR JOINT ILL.

The animal is lame, or may even be unable to rise. The affected joints contain a clear fluid which may, however, become purulent, and abscesses may form in the neighbourhood of the joint. When the disease is severe, the flesh becomes dropsical, in which case it becomes unfit for human consumption.

PARASITIC DISEASES OF ANIMALS.

There are three main types concerned, *viz.*—

The Trematodes, which are flat worms possessing an alimentary canal and are nearly all hermaphrodite.

The Cestodes, which are long flat worms possessing no alimentary canal. They are hermaphrodite. The adult worm inhabits the alimentary canal.

The Nematodes, which are long and cylindrical in shape. They possess an alimentary canal and the sexes are separate.

It is possible to refer only to a few of the more common worms which are found in animals and which in turn affect man. Those mentioned are more or less typical of their class, and are mentioned as such and not necessarily because they are found in India.

Fasciola Hepatica (The Liver Fluke).

This worm belongs to the order of Trematoda.

Its geographical distribution is cosmopolitan.

Its hosts are man, cattle, sheep, swine, and sometimes the horse and rabbit.

It is very common in the bile ducts and liver of sheep, less so in cattle.

Its habitat is the liver and bile ducts.

The Distoma Hepatica are flat, conical worms, always longer than broad. At the anterior end is situated the mouth surrounded by a sucker. A second sucker is situated in the median ventral line. The surface of the flukes is generally more or less covered with minute spines.

The digestive tract consists of the mouth and pharynx, below which is a circular muscle which cuts off the œsophagus from it. Near the ventral sucker, the œsophagus divides into two blind sacks which run parallel to the sides and give off branches which again divide. A few short branches are given off internally. None have an external opening. A central canal runs from the junction of the upper and middle third to the posterior end of the worm, terminating in the foramen caudale. At the anterior end it has three branches, one medial and two lateral; the main trunk gives off branches which subdivide.

Genital organs.—The worm is hermaphrodite. The genital pore is in the median line, just above the ventral sucker. The penis is in a pouch which also encloses the receptaculum seminalis into which run the vasa deferentia from the testes, which are two in number. The female organ comprises the vaginal orifice which is very small and is situated in the genital pore near the penis. The uterus is much coiled and lies just above the testes.

Life-history.—This is very complex, for the adult parasite, instead of producing young similar to itself and capable of developing into adults in cattle, produces eggs which develope into organisms totally different to the adult form living a parasitic life in other animals. The ova are oval in shape and about ·14 m.m. by ·11 m.m. in size. They are ciliated and have an operculum and contain an embryo. The eggs escape from the uterus of the adult and are carried to the intestine of the host with the bile, and then pass out with the fæcal matter. Many of them become dried and undergo no further development, but others are dropped in the water of marshes or into damp soil. After a longer or shorter time a ciliated embryo is developed; the time varying with the temperature: at 20° to 26° (C.) it takes 10 days to 3 weeks, at 16° (C.) 2 to 3 months. As long as the eggs remain in the dark, the miracidium will not escape from the egg. When, however, the free swimming ciliated miracidium does escape, it swims in the water and seeking out certain varieties of snails, attacks them and seeking the liver there developes into a sporocyst which grows slowly at first and then more rapidly. When they are about two or three weeks old, redia escape from them and in the liver of the snail increase in size. The redia has a mouth pharynx and a blind intestinal canal.

The redia as well as the sporocyst may be looked upon as a female organ, and in its body cavity are found a number of germ cells which develope into cercariæ, which resemble the adult in having suckers and an alimentary canal; but they have no genital organs. They hava a large tail. When developed, they leave the body of the sporocyst or redia and the snail and swim about in the water. After a time they attach themselves to blades of grass, etc., and lose their tail. They now remain quiescent until they are swallowed by some other animal, when, *via* the gall-ducts or possibly the portal veins, they reach the liver where they develope into the adult hermaphrodite. This curious development lasts about 10 to 12 weeks, and there is a constant potential increase in the number of individuals ; for the sporocyst may give rise to 5 to 8 redia and each redia to 12 to 20 cercariæ and each adult to from 37,000 to 45,000 eggs. This fertility is necessary because the life-history is complicated, and comparatively small chance exists for any one egg to complete its life-history. As a general rule, it can be said that the disease is found usually on the low-lands, marshes, valleys, etc.

If the disease be not widespread, only the liver of the sheep need be destroyed.

If there is marked anæmia, cachexia, general weakness and bile discoloration of the tissues, the flesh should not be placed on the market.

In the sheep the worm is easily demonstrated by pressing on the bile ducts.

Cestodes or Tapeworms.

The more important cestodes, as far as meat inspection is concerned, are four in number, *viz* :—

(1) Tænia Mediocanellata (Synonym, Tænia Saginata),
(2) Tænia Solium,
(3) Tænia Echinococcus, and
(4) Bothriocephalus Latus.

The cestodes are long, ribbon-like worms. They exist in different forms in the alternate hosts. The adult tapeworm inhabits the intestinal canal.

Tænia Mediocanellata (Cestode).

The Tænia mediocanellata (*Vel.* Saginata) is the commonest found in England. It is distributed over the whole world, being found in Europe, Asia, Africa, America and Australia. Its chief host is man and its intermediate host is the ox.

Description of the adult worm found in man.—This tapeworm can approach 25 feet in length. The whole body of the tapeworm (the strobila) consists of a head and neck (the scolex) and a series of segments (the proglottides).

The head is somewhat square-shaped, about ⅛th of an inch in size, and is provided with four suckers. There are no hooklets and no rostellum. There is much pigmentation, however. Growing out from the posterior end of the head is the thin neck which merges into the segments or proglottides. Each proglottis is hermaphrodite. The male organs comprise testes and vasa deferentia. The female organs comprise ovary, uterus and vagina. The uterus is composed of two main branches and a large number of ramifying lateral branches, which are so numerous and closely packed as to appear parallel. They number 20 to 30. The genital pose is sometimes alternate but may vary greatly.

The proglottis has a narrow anterior part and a broader posterior. In all there are a vascular apparatus and sexual organs.

The ova are impregnated in the uterus and, after a lapse of time, pass down to the vagina.

The Tænia mediocanellata produces about 1,200 segments and from about the 600th each segment is sexually mature.

Life-history.—Starting with the adult tapeworm in the intestine of man, the egg escapes from the uterus of the worm and passes out with the excreta, or segments containing eggs may break loose and pass out. In either case, the eggs become scattered upon the ground or in water and reach cattle by their food or drink.Upon arriving in the stomach of the ox, the egg shells are destroyed. The embryo then bores its way through the intestine walls with the aid of six minute hooks with which it is provided and wanders to the muscles where it rests ,or if it bores its way into a vessel, it may be carried by the blood to any organ in the body. When it comes to rest, it loses its hooks and increases in size, developing into a small round bladder worm. The head of a future tapeworm is then developed in an invagination of the cyst wall, and the complete organism thus formed is known as a cysticercus or bladder worm. The total time taken is about 7 to 18 weeks.

The Cysticercus bovis has been found in the skeletal muscles, heart, the adipose tissue round the kidney, subperitoneal connective tissue, lymphatic glands, brain, lungs and liver.

It lies between the muscular fibres.

It is not known in the human subject. It is white or grey in colour and has a small yellowish spot on it due to its invaginated head. The bladder contains but little liquid and has only one scolex.

These bladder worms are specially seen in the jaw, muscles, diaphragm, tongue and shoulder. The breast, eyelids and heart are also frequently affected.

The only parasites likely to be confused with the cysticercus are (1) the Cysticercus tennicollis which, however, has 28 to 40 hooklets, and, moreover, is found under the serous membranes of the body cavity and not in muscles ; and (2) the Tænia echinococcus in which either the head is absent, or there are numerous armed heads in brood capsules, the cuticle is thick and laminated and its form is round, whereas in the Cysticercus bovis the form is oval, the cuticle thin and there is an unarmed single head.

Tænia Solium (Cestode).

The Tænia solium is very common in Ireland and Germany. The adult stage is seen in man, and the larval (the Cysticercus cellulosæ) in the pig.

The adult worm as found in man.—The head is smaller than that of the Tænia mediocanellata measuring about ½ inch. It has four suckers and a rostellum, at the base of which are two rows of hooklets numbering about 26 and rarely exceeding 30. It is smaller than the Tænia media and but seldom reaches more than 15 feet in length. The proglottides resemble those of the Tænia media in shape, but are smaller. The genital pore is lateral and alternates regularly. The uterus is less branched, having about seven to ten only. There are about 850 segments, each being sexually mature after the 450th.

Life-history,—The life-history is exactly the same as in the Tænia mediocanellata, except that the pig, and not the ox, is the intermediate host, and that this bladder worm is occasionally found in man. It is rare to find more than one T. mediocanellata in the same patient, but several cases are on record of two or more T. solia being found. The pork bladder worm is larger than the beef, reaching a maximum of half an inch. They are usually found in the muscles of the tongue, neck, shoulder and in the liver and kidneys, abdomen, jaw, inter costals, diaphragm, pectorals and the adductors of the hind legs. The parasite in the pig which is most likely to be confused with the Cysticercus cellæ is the Cysticercus tennicollis, which is not transmissible to man. It is larger and has more hooks (28 to 40) and is found under the serous membranes of the body cavities and not in muscles.

Both measly beef and measly pork should be condemned.

Tænia Echinococcus (Cestode).

The Tænia echinococcus is perhaps the most important parasite in meat inspection.

Its parasitic life is spent in any organ, but more particularly in the lungs and liver of man, cattle and sheep. The adult stage is seen in dogs, but not in man ; when eaten by dogs the hydatid developes into an adult tapeworm. It is also seen in the dingo, jackal and wolf.

The disease in man caused by the larval stage of this worm is known as Hydatid Disease.

The disease is very common in Ireland, India and Australia ; it is also seen in England.

Description of the adult worm.—The head is much smaller than that of the two preceding worms. It is about $\frac{1}{40}$ inch. There is a rostellum and also a double row of hooklets of two different sizes. In all, the hooklets number about 30 or 40. There are also four suckers.

Proglottides.—There are four segments only, of which the 4th alone is mature.

The worm is about ¼ inch long and the structure is but ill-defined. The uterus is central and presents a rosette appearance. The genital pore is laterally placed.

Life-history.—Starting with the adult worm in the small intestine of the dog, wolf or jackal, the eggs are scattered on the ground and are swallowed by the intermediate hosts (man, cattle, sheep, swine) in water or food. Upon arriving in the stomach, the six-hooked embryo escapes from the egg shell and wanders, or is carried, to various organs of the body, *e.g.*, liver, lungs, ovaries, bones or skull, where, losing its hooks, it developes first into an acephalocyst, which may develope further. Any heads formed upon being swallowed by a dog, wolf or jackal then develope once more into an adult worm.

The cyst after a short time is seen to be composed of two layers : (1) a striated chitinous external layer, and (2) a parenchymatous layer of two parts, a superficial granular and a deeper cellular containing a water vascular system and muscular fibres.

Soon this inner parenchymatous layer becomes vesiculated and very granular here and there, a small cavity forms in which developes a scolex with a row of hooklets and four suckers. This may occur at several places. These daughter cysts separate and go into the body of the main cyst. If any of these scolices are eaten by the dog, etc., they develope into an adult tapeworm.

Sometimes a cyst remains single, and at other times it produces a large number of daughter cysts (seen commonly in man). Sometimes the daughter cysts are contained in fissures in the outer layer, finally becoming free outside (seen in cattle—Echinococcus veterinorum). Sometimes many cysts appear which are not connected together, called Echinococcus multilocular ; lastly, occasionally in the liver, lungs and peritoneum of cattle, a large cyst is found without any head or hooklets in it. It is then recognised as an hydatid by the fact—

(1) that the fluid has no albumen in it ;

(2) that the fluid has a low specific gravity;

(3) of the presence of the chitinous external layer.

This variety of cyst is known as an acephalocyst.

It must be remembered that the daughter cysts may give rise to grand-daughter ones.

Organs infected with the Echinococcus should be most carefully destroyed, so as to prevent dogs, etc., eating them.

In a country where the disease is prevalent, the companionship between man and dog should not be too intimate.

Under no circumstances should any dog ever be allowed into a slaughter-house.

All stray and ownerless dogs should be destroyed. This is a most important point in the prevention of the spread of this disease, and should never be neglected.

Bothriocephalus Latus (Cestode).

Bothriocephalus Latus is seen frequently in Russia, Sweden, Switzerland and Japan. It is rare in England. It is a very large worm and may attain 25 feet in length; it is reddish-grey in colour.

The adult life is passed in the intestine of man, dog and the cat.

Its intermediate host is the common pike, the ling, the perch, and several members of the genus salmo.

Description of the adult worm as found in man.—The head is long and narrow. There are no hooklets, no rostellum and no suckers, but in place of the latter are two lateral slits or grooves like suckers.

The proglottides number about 4,000 and are sexually mature from about the 600th. They are short and broad. The genital pore is central and the uterus is rosette shaped.

The cystic stage is not fully known. The larvæ which escape from the operculated eggs are ciliated and swim in the water for a long time, until eaten by certain fish (pike perch, etc.), when the cilia and 6 hooklets are lost. It is subsequently conveyed to man in his food.

The Gid Bladder Worm. (Cœnurus Cerebealis) (Cestode). The larval stage is passed in sheep, calves and goats and the adult stage in dogs and wolves. (*Tœnia Cœnurus*).

Life-history.—Starting with the adult worm in the intestine of the dog, the eggs are scattered on the ground, and living 3 or 4 weeks in a moist place are taken up by sheep or calves along with their food or water.

On becoming free in the intestine, the embryo bores its way through the internal wall and reaches the brain or spinal cord, probably aided in its wanderings by the blood current. Arriving in the brain, the young worm loses its hooks and developes into a cyst, which preserves for some time the power of locomotion, and burrows small canals in the nervous tissue. In 14 to 19 days after infection, small cysts are found in the brain substance and similar structures are sometimes found in the muscles, especially of older animals. Those in the muscles generally atrophy and those in the brain develope causing the symptoms of Gid or Staggers.

When found in the sheep, the parasite should be destroyed by heat so as to prevent infection of dogs. In dogs the Tænia Cœnurus developes in 3 to 8 weeks.

Trichinosis (Nematode).

The disease is due to the presence of the trichina spiralis. This parasite is found affecting man almost throughout the world, especially where much pork is consumed, and when insufficiently cooked. The natural host would appear to be the rats and the disease is kept up by the habit they have of eating their dead. Pigs eat rats and perhaps portions of other infected pigs, and finally man eats the pig. The trichina spiralis in its adult stage lives in the small intestine. Its larval stage is passed in the muscles. It is communicated to man by eating the flesh of pigs and the disease Trichinosis is due to the emigration of the embryo. Trichinæ, present in the flesh of the pig, if encapsulated, may be seen with the naked eye as small round white specks, but often a microscope is necessary. To prepare a section, take a thin slice of flesh, place it in some liquor potassæ (1 in 9) and let it stand for a few minutes till the muscle becomes clear. The white specks stand out clear and the worm can be seen coiled up inside. If the capsule is too dense to allow the worm to be seen, add a drop or two of acetic acid. The cysts lie with their long axes parallel to the muscle fibres. The larvæ in the muscle are about ·6 to 1 m.m. in size; they lie coiled up in an oval capsule which is at first translucent but later opaque and perhaps calcified. At either end of the capsule are small fat globules. When the diseased flesh is eaten by man, pig or rat, the capsule is dissolved and the embryo is set free. The larvæ develope in the intestine and become sexually mature in about 2½ days, and the female, after impregnation, produces about 1,000 eggs. In about one week these eggs set free small worms, and the male and female adult worms disappear. The adult male measures about 1·2 to 1·5 m.m. and the adult female about 1·5 to 2·0 m.m. As soon as born, the embryo trichina leaves the intestine and (*via* the peritoneum and connective tissues) in all directions penetrates to and lodges in the muscles, especially in the diaphragm and tongue muscles near their tendons. From the time of ingestion of the food to the lodgment of the worms in the muscles about two weeks elapse. Sometimes 2, 3 or 4 worms may be seen in one capsule. In 3 or 4 weeks these larval worms become fixed in their final position in the muscles and do not undergo any further development. The capsule gradually becomes thicker and may become calcified; in man this may occur in about 4 to 6 months, but, in the pig, it may be delayed for many years. Once lodged in the muscles, the larvæ may live for an indefinite number of years. Experimentally one can infect guinea-pigs, rabbits and cats, and with difficulty dogs. In the pig trichinæ, like the cysticercus, cause few, if any, symptoms The animal may appear quite healthy and well nourished.

Mode of Infection.—The disease is conveyed by the ingestion of imperfectly cooked pork. If all parts of the joint are thoroughly cooked, the danger is perhaps remote. Salting and smoking are quite insufficient to afford protection

Symptoms, etc., produced in man.—A few days after eating infected pork, there is pain in the abdomen, loss of appetite, vomitting, and sometimes Diarrhœa: the latter is by no means always constant, but it may be very severe. In addition there may be general debility and pains in various parts of the body. Between the seventh and tenth day, but sometimes not till the fourteenth, chills may occur, but not commonly. There is generally Fever, sometimes of an intermittent type and sometimes of a remittent type, pain on pressure and movement of muscles, accompanied by swelling of the same, and, if the muscles of the jaws and of the larynx and pharynx are involved, there is some difficulty in mastication, deglutition and respiration. In severe cases the involvement of the diaphragm and intercostal muscles causes Dyspnœa which may prove fatal. Œdema may occur often early in the face and later in the extremities when the stiffness and swelling of the muscles are at their height. There may be profuse sweating, tingling and itching, and occasionally Urticaria has been seen. The general nutrition is impaired and there is emaciation and Anæmia. The patella reflex is absent. The sufferer is usually conscious except in very severe cases when there is delirium, dry tongue and tremors as in Enteric Fever. Bronchitis,Pleurisy and Pneumonia may supervene and prove fatal. The prognosis is variable, the mortality ranging from 2 to 30 per cent. In mild cases recovery occurs in from 10 to 14 days. In the more severe cases it occurs in from 6 to 8 weeks. The prognosis is more favourable in children and when early Diarrhœa and moderately severe gastro-intestinal disturbance is manifested. Constipation is unfavourable. The most important diagnostic points are the pains and swellings in the muscles, the presence of œdema and the shortness of breath.

In the pig the capsues are specially to be seen in the tongue, diaphragm and intercostal muscles.

Trichinosed flesh should invariably be condemned.

MILK.

Milk is the natural secretion of the adult female mammal intended for the use of its newly-born offspring. Milk contains all the constituents needed for the entire nutriment of a young growing animal. The constituents of milk—fats, sugar and proteids, are all formed from the protoplasmic contents of the cells of the epithelium lining the ramifications of the ducts of the mammary gland through the vital activity of the cell itself. This fact must be borne in mind as it is generally assumed that a diet rich in fat would naturally increase the proportion of this constituent in milk; but this is not so; the reverse is the case. In a fatty diet all fats taken up by the lacteals of the intestines are consumed in the production of heat and energy; all fats not so taken up are discharged with the dung. Metabolism in the organism is stimulated to greater activity by nitrogenous foods; it is retarded by fatty foods, and all the fats obtained in milk are derived from albuminoids and not from fats and carbo-hydrates; the latter are consumed in the production of heat and energy. It is found in practice and by experiment that a cow at grass yields in her milk more fat than is ingested with her food. The sugar too is formed by the same protoplasm and not from the carbo-hydrates taken in with food.

Milk whether human or animal is essentially of the same constitution, and as cow's milk has been most thoroughly investigated and enters largely in the diet of man and infant, it will be treated first. Cow's milk, as obtained, is an emulsion, consisting of particles of finely divided fat, suspended in a solution of protein bodies, milk, sugar and salts. It is non-transparent, white or with a slight tinge of yellow, and having faintly sweetish taste. The particles of fat and solids are uniformly diffused.

The reaction of fresh milk is generally amphoteric towards litmus and turmeric papers. Milk when exposed to air gradually changes, and the reaction becomes more and more acid: this change depending on the gradual transformation of milk-sugar by the action of micro-organisms. The composition of milk is fairly constant in each species; and this is strictly true so far as casein and sugar are concerned but the percentage of fat varies, depending on the period of lactation and age. A highly *nitrogenous* food increases the fatty constituents ; oily food increases the quantity but renders it *watery*, hence the practice of the *gowli* to feed his cattle on cotton seed.

Fresh milk does not coagulate in boiling but forms a pellicle consisting of coagulated casein and lime salts ; if this is removed, it reforms. The property of coagulation increases with the formation of lactic acid, until a stage is reached where milk coagulates forming a solid mass at ordinary temperature. Milk undergoes various fermentations ; the chief of which is the lactic acid fermentation produced by the action of the Bacillus acid lactici of Hueppe.

Besides the lactic acid fermentations, milk undergoes other fermentations owing to the action of certain bacteria. Thus succinic and volatile acids such as butyric, acetic, etc., may be formed. The lactic acid, etc., are formed chiefly by the decomposition of milk-sugar or lactose. If a little "rennet" be added to fresh milk, it coagulates quickly to a solid mass, from which a yellowish liquid or sweet whey is pressed out. This coagulation occurs without any formation of lactic acid.

Constituents of Milk.

Milk is made up of milk plasma in which fat-globules are suspended and contains proteins : (1) casein, (2) lacto-albumin, (3) lacto-globulin, (4) nuclein ; also carbo-hydrates, chief of which is lactose or milk-sugar and certain extractives, creatine, cholesterin, lecithin and mineral salts.

Casein belongs to the group of nucleo-albumins, contains phosphorus and coagulates with rennet enzyme ("*rennin*") in the presence of a sufficiently large amount of lime-salts. The curd thus formed contains large quantities of calcium phosphates. In the process of coagulation a cleavage process occurs : the casein is split off as para-casein and whey-protein, the latter remaining in solution. In the digestion of casein with pepsin and hydrochloric acid, a phosphorised proteose substance is formed which is further split off in the tryptic digestion as ortho-phosphoric acid and pseudo-nucleine. Protein in milk ranges between 2·5 to 5 per cent.

Lactose or milk-sugar is a carbo-hydrate and is always in solution. Milk-sugar is split into dextrose and galactose by the action of an enzyme "lactase" existing in yeast. Preparations of "milk wine" or "koomyss" from mare's milk and "kephyr" from cow's milk are based upon this fact. Other organisms, such as Bacillus acidi lacti, produce lactic acid fermentation in the milk-sugar, rendering the milk sour. After this is fully established, the casein begins to decompose, and protein-ptomaines of a highly poisonous nature are formed.

Other micro-organisms produce a change in the character of milk. Thus Proteus vulgaris renders it bitter by formation of peptones; Micrococcus viscosus renders it slimy and ropy. Besides these, other organisms, such as Bacillus butyricus, produce coagulation and butyric acid fermentation. Some bacilli change the colour of the milk: thus B. cyanogeneus renders it blue, B. synxanthus yellow, Micrococcus prodigiosus red. In all these cases the milk so rendered is unsuited for food and may cause dangerous poisonous symptoms. The quantity of lactose in milk ranges from 3·5 to 6 per cent. The mineral bodies in milk are calcium and magnesium phosphates and chloride salts of potash and sodium. It contains a very small amount of iron and citric acid.

Milk fat consists of extremely small globules of fat suspended in milk plasma: they occur in milk as an emulsion. Each milk globule is enveloped in a fine membrane or stroma-substance. Milk fat separates on standing and forms cream; warming hastens the process of formation of cream, but does not increase it in quantity, while an artificial centrifugal separator does and that in a very few minutes. Milk fat consists of olein and palmitin with triglycerides of volatile fatty acids. Milk fat constitutes about 3·5 to 6 per cent. of the total weight, but good milk contains about 8 to 12 per cent. of cream. The water in milk varies from 85 to 88 per cent.

In India the milk of the buffalo is very largely consumed, even more so than that of the cow. The reasons for this probably are: (1) the yield of milk per buffalo is greater than that of the cow, hence commercially, other things being equal, it is more advantageous to the supplier; (2) buffalo milk is richer in total solids and fat; hence a superior and larger return in the produce in cream and butter, etc.

The composition and quantity of milk supplied depend on the breed, stock and age of the buffalo.

Chemical Composition of Milk and Milk Standards for India.

The composition of milk in India differs from that of milk in Europe and America in many respects. Besides cow's milk there is buffalo's milk to be dealt with in India. The latter shows a higher percentage of proteids and fat. The only data available in India are those of Mr. A. A. Meggit and Dr. H. H. Mann of the Imperial Department of Agriculture and the results arrived at by Dr. L. L. Joshi at the Bombay Municipal Laboratory. The former were obtained at the Government Dairy Farm in Poona, which is situated in close proximity to the Laboratory of the Agricultural Chemist to the Government of Bombay. The latter are from samples collected in Bombay from dairies, milk shops, milch cattle stables, milk vendors and *Gowlies*. The following figures are given by Meggit and Mann for the composition of mixed Indian buffaloes' milk at Kirkee ("Memoirs of the Department of Agriculture in India;" "The composition of the milk of some breeds of Indian cows and buffaloes and its variations." Part II, p. 199, by A. A. Meggit, B. Sc., and Harold H. Mann, D. Sc.) :—

Water	..82·22%
Fat	.. 8·09%
Proteids	.. 4·34%
Milk sugar	.. 4·56%
Mineral matter	.. 0·76%
	99·97
Solids not fat	.. 9·69
Specific gravity at .. 15·5° C ..	1032·1

At the Bombay Municipal Laboratory the following average was obtained by the late Dr. Ghadially in a series of over fifty samples :—

Specific gravity at 60° F.	1031·5
Total solids	17·5%
Fat	8·2%
Solids not fat	9·3%
Milk sugar	4·9%
Proteids	4·0%
Ash	0·8%

For a routine examination the following constituents only need be found out, *viz.* :—

Total solids, fat, specific gravity and "solids not fat." Great variations are found depending on many factors such as breed of animal, the kind of feed, time of calving, season, time of day, &c.

It appears that the amount of milk given by the Delhi and Jafferabadi breeds is usually more than the yield of Surti buffaloes. The milk of the latter breed is however found to be much richer in fat than that of the others.

Meggit and Mann (*ibid* p. 200) give the following figures for fat :—

Date.	Number of samples.	Percentageof Fat.	
		Morning milk.	Evening milk.
January, 1908	6	6·6	8·0
February ,,	19	6·9	8·4
March ,,	21	6·9	8·0
April ,,	16	7·0	7·4
May ,,	17	7·5	8·0
June ,,	13	6·7	7·8
July ,,	6	7·0	8·1
August ,,	4	7·2	7·5
September ,,	10	6·7	7·5
October ,,	12	7·0	7·6
November ,,	7	7·9	8·3
December ,,	12	7·4	8·0
January, 1909	12	7·2	8·2
Average	155	7·06	7·92

Dr. Lemuel L. Joshi, Municipal Analyst of Bombay, gives the following figures taken from 271 "genuine" samples of buffaloes' milk examined from time to time at the Bombay Municipal Laboratory. Most of these were samples of morning milk :—

Average Composition.

Months.	Number of samples.	Specific gravity at 60° F.	Total solids %	Fat %	Solids not fat %
January ..	31	1029·41	17·76	8·21	9·55
February ..	30	1029·79	17·35	7·7	9·65
March ..	9	1028·83	16·94	7·11	9·83
April	20	1029·06	17·37	7·57	9·80
May	26	1029·36	16·96	8·15	8·81
June	22	1028·63	17·45	7·81	9·64
July	33	1028·58	17·50	7·64	9·86
August ..	30	1027·41	17·73	8·06	9·67
September ..	13	1028·18	16·75	7·33	9·42
October ..	17	1028·07	17·04	7·41	9·63
November ..	24	1029·30	16·57	7·26	9·31
December ..	16	1029·77	16·94	7·22	9·72
Total ..	271				

The results obtained by Mr. Meggit and Dr. Mann in Poona and by Dr. Joshi in Bombay show that the average percentage of fat in genuine buffalo milk may be taken as 6 to 8 per cent. but should nerver be below 5 per cent. The "solids not fat" are usually found to be between 9 and 10 per cent. This may be taken as the standard of buffalo milk in India.

As regards *Cow's milk* the percentage of fat is higher in the case of Indian cows than in European or American cows. In other respects there is not much difference. Meggit and

Mann give the following as the "average composition of milk of cows of the Poona Dairy Herd":—

Date.	Number of Samples.	Percentage of Fat.	
		Morning Milk.	Evening Milk.
January, 1908	6	3·98	5·30
February ,, ...	19	4·10	5·20
March ,, ...	22	4·34	5·30
April ,, ...	15	4·50	5·40
May ,, ...	18	4·40	5·20
June ,, ...	13	4·20	5·20
July ,, ...	5	4·50	4·90
August ,, ...	5	5·00	5·90
September ,, ...	10	5·00	5·10
October ,, ...	12	4·50	5·10
November ,, ...	7	4·90	5·60
December ,, ...	12	4·80	5·85
January, 1909	12	4·50	5·77
Average	156		

The following is the average composition of cows' milk in Bombay:—

Specific gravity at 60° F..	1030.87
Total solids %	13·9
Fat %	4.85
Solids not fat %	9.04

It would appear from these figures that in genuine samples of milk of Indian cows the amount of fat should not fall below 4 %.

Adulteration of Milk.—Out of a total of 1,363 samples of milk examined at the Bombay Municipal Laboratory during a period of five years, only 282 were found to be genuine. This gives 79·3 per cent. of adulterated or watered samples of milk in Bombay. There may also be a fraudulent abstraction of cream on the part of the milk supplier.

Until recently, even in Presidency towns, the stabling of milch cattle was most insanitary. Municipal bye-laws are now being brought into operation for the provision of proper sanitary stabling with sufficient cubic space accommodation for each animal. There was a time when animals were huddled together, without even sitting accommodation, and in consequence there was great overcrowding. Improved expert supervision is now provided and the milch cattle stables are regularly inspected by the Veterinary and Sanitary Inspectors, who see that the stables are kept in proper sanitary condition ; special attention is paid to the drainage and the dung receptacle. Stabling accommodation is insufficient in a city like Bombay for the number of animals required for the milk supply of the population of the city. The milk suppliers therefore are compelled to stable their animals near a Railway Station within a reasonable distance of the city or purchase milk from others in the neighbouring villages and stations. On the Western side of India the buffalo takes the place of the European or the Northern India or Calcutta cow. These animals are stabled on the outskirts of the city and elsewhere in cadjan sheds, without sufficient air or sitting space. The floors are *kutcha* and covered with a thick layer of excreta of animals. There is no drainage—or if any, to a cesspool which is never emptied. The animals' hind quarters are dung laden, and the udders thickly coated with dung or mud. There is no separate place for storage of milk. The shed itself is dark and ill-ventilated and offensive-smelling. Major S. A. Harris, I.M.S., in his note on milk supply of towns says, referring to Lucknow :—

"I proceeded down a narrow paved lane and came to a brick yard or open square, which is Municipal property. I found that this had been thatched over, that nineteen buffaloes were kept in the area. Heaps of rotting manure were stacked on one side of the square, the floor was covered to a foot or more with dung. The drains were blocked with it and the stench was abominable. In charge of these cattle were two lepers, one with no fingers and simply able to feed the animals and the other with only stumps of fingers left, but probably sufficient to allow him to milk the cows."

In connection with such stables, one often notices dwelling rooms either on the loft of the shed or by the side of it, and it has been the experience here that cases of Small-pox or other infectious diseases have been removed to isolation hospitals from such rooms.

The mode of collection too needs a little description. The milkman may or may not wash or clean the udders or may only just throw water on them ; but usually they show dry dung adherent to the hair. The dust-laden tail, whisked about to drive away flies, adds its quota to the milk. The brass *lota* in which the milk is collected has been washed with the contaminated water of a neighbouring well. The hands of the milker may be clean or full of dirt, but without any attention to their cleanliness he proceeds with the milking of the animal. The *lota* receives the expressed milk, with all the dirt of the hand, udders and tail added on to it. The milk thus collected into large brass *lotas* is now ready for transit, and to prevent splashing and tilting up of its contents during transit, hay, straw or green grass from the stable floor is put into it to cover the opening. No provision is made to guard against the ingress of dust, etc. In this condition it is exposed for sale in the milk market or sold to retail vendors. Here it may become further contaminated. Experience has proved that milk will not keep sweet for any length of time ; this is due to the fact that it is contaminated with bacteria during collection and transit. It is a matter of common knowledge that milk is the best medium for bacteria to multiply, and their products spoil the milk. Several methods have been devised to keep the milk as sweet and fresh as possible without any prejudicial effect on the milk.

Bacteria in Milk.

Milk, as secreted by a healthy animal, is a sterile fluid. It may be contaminated in various ways from the udder to the consumer.

The sources by which bacteria may gain access to milk may be grouped as follows :—

(1) Intra-mammary.

(2) Introduced during the milking process.

(3) From milk utensils.

(4) By contamination during transit.

Bacteria may enter the lactiferous ducts from outside as there is no special obstacle to prevent their entry, the only one being the sphincter muscle at the lower end of the teat. The "fore milk" contains most of the bacteria, but the latter milk or "strippings" least. The most frequent bacteria found are the streptococci, staphylococci and pseudo-diphtheritic bacilli. All these gain access to the milk cistern, through the milk column in the teat canal in the udder, and also to the finer ramifications of ducts from outside through the teat orifices. Bacteria introduced during the milk collection may be from (1) hair, udder or teat of the animal; (2) from dust of the milk shed or clothes of milker or from dirt of the hands of the milker. As the hind quarters and udders of the animal are laden with dry or wet dung, some of it, of necessity, finds its way into the milk pail. The air and dust of the shed are full of bacteria, which may contaminate the collected milk either during the process or when stored, as the pails are almost always uncovered. Milk vessels when improperly cleaned form a grave source of contamination of milk. The water used for cleaning these vessels must be from a pure source. During transit of milk it may be contaminated if not conveyed with tightly fitting covers. It can be imagined how badly milk may be contaminated in India by the *gowli,* who covers the milk, to prevent splashing, with a handful of hay, straw or green grass which he finds handiest, or again, when exposed for sale in open *lotas* in the streets, it may receive dust laden with particles of dried street and domestic refuse; flies, which may have fed on excreta and other decomposing matter, may alight into the same.

The streptococci found in milk indicate that the pollution is undesirable if from outside, or that they are derived from local pathological lesions such as mastitis or ulceration in the udder. The former may be saprophytic and harmless while the latter pathogenic and harmful. Staphylococci are almost always abundantly present in milk, but their presence does not indicate any pathological significance. The presence of streptococci indicate manurial pollution, and they are harmful to infants inasmuch as they cause Gastro-Enteritis and infantile Diarrhœa ; Bacillus coli and allied forms indicate an undesirable pollution either manurial or fæcal and such contamination may be obviated by observing scrupulous cleanliness during milking. B. coli and coli-like bacilli are lactose fermenting bacteria of intestinal origin and their presence in milk is largely proportional to the amount of cleanliness exercised during milking.

Bacillus enteridis sporogenes shows that the pollution is manurial or fæcal, as the spores of the same occur abundantly in fæces and dung.

Bacillus butyricus resembles the enteridis sporogenes. They are both anærobic and both seem not harmful to man ; B. enteridis, however, is of importance as it indicates pollution from dung. Besides these there almost always occur B. subtilis, B. mycoides, B. mensentericus vulgatus. These are aerobic but non-pathogenic. They indicate contamination from outside, probably hay, and have a decomposing effect on milk. They are also very heat-resistent and therefore constitute most of the bacilli left in imperfectly sterilized milk.

Acute Infectious Diseases and Milk.

Milk may be infected by the specific organisms of infectious diseases. The infection may be conveyed by direct human infection, or indirectly, or may be of bovine origin, either direct or indirect. Direct infection may be from persons actually suffering from infectious diseases, or have recently suffered and act as carriers ; or the milker may have somebody ill with infectious disease in his family. Milk may be adulterated with water containing Typhoid or Cholera vibrios, either by the addition of such water or cleaning of vessels with such water, or also by the animals, while drinking such water, contaminating their udders. When milk is the cause of infection, the incidence of disease is only upon those households to which the milk is supplied. Some of these households may escape, as the milk in those may be boiled and rendered harmless, while others, where milk is not boiled, may suffer severely, or in some instances they may have been protected by a previous attack and thus gained immunity.

Milch Cattle.—Many milch cattle suffer from acute diseases, and their yield of milk changes in quality and may produce harmful effects on the consumer. Thus an animal may suffer from acute infectious disease, such as bovine Scarlatina or acute bovine Tuberculosis. Such milk is decidedly harmful. Instances have been known where Foot and Mouth Disease was communicated to man. The animals may suffer from inflammation of the udder or have ulcerated teats.

All outbreaks of infectious disease due to milk are sudden and explosive, of short duration and come to an abrupt and equally sudden termination. There have been many epidemics which were distinctly traced to this kind of infection. There have been epidemics of Typhoid, Diphtheria, Scarlet Fever, and septic affections of the throat, Diarrhœa and Cholera. It also happens that milk if not properly cooled before transit to a long distance, or if kept too long or in a dirty pan, becomes poisonous, ptomaines forming in the same. A ptomaine was isolated by Dr. R. H. Firth, I.M.S., of the Punjab,who called it *lacto-toxine* ; independently of him, another observer, Vaughan of Michigan (America), also isolated a ptomaine and called it *tyro-toxicon.* The symptoms produced by this ptomaine are severe gastro-intestinal irritation with marked effect on the nervous system, the symptoms simulating those of Cholera. In April, 1911, in a Mahomedan quarter of this City certain guests, who attended the celebration of a wedding, suffered severely from ptomaine poisoning. Careful inquiries were made and it was discovered that only those who partook of milk and ices suffered severely.

In connection with this it is necessary to mention that two other milk preparations are liable to cause these symptoms : (1) *Mawa* is desiccated milk ; it is prepared for commercial purposes in Gujarat by exposing milk in pans to a slow heat. It is sold in Indian *bazaars* in pieces and used in the preparation of sweets and ices. Dr. Joshi, the Municipal Analyst, examined bacteriologically many samples of *Mawa.* In the majority of samples examined, Bacillus coli communis and coli-like organisms were detected; there was also found in large numbers streptococci and staphylococci showing contamination of an excrementitious nature. (2) *Basundi* is another preparation of milk. It is prepared in the same manner as *Mawa,* but the process stops when milk has come to thick consistence; condiments are then added and well-mixed. This makes a highly delicious preparation and is indulged in by the wealthy. It is exposed for sale in brass *lotas,* where it may be contaminated, or kept long enough to develope ptomaines. Instances have been known where whole families have suffered severely after indulging in such sweets. The symptoms were of severe gastro-intestinal irritation not unlike Cholera.

Bacteriological Examination of Milk.

This is for the purpose of finding out any contamination with microbes, dirt, cow-dung, &c. There are hardly any data available in India excepting the recent investigations carried out by Dr. L. L. Joshi at the Bombay Municipal Laboratory. The following is a brief summary of Dr. Joshi's researches which are being continued :—

Microbes per c.c.—86 samples of milk were collected at random from dairies, milk shops, cattle stables, railway stations, &c., and examined with the following results :—

Da e.	No. of samples.	Average No. of microbes per c. c.
April, 1913	12	46,363,000
May, ,, ...	30	63,481,700
July, ,, ...	31	35,801,612
August, ,, ...	13	29,750,000

Microbes per c.c. in 87 samples of milk expressed in millions.

Less than 5 millions.	Above 5 and less than 10 millions.	Above 10 and less than 20 millions.	Above 20 and less than 30 millions.	Above 30 and less than 50 millions.	More than 50 millions.
2	9	7	18	10	41

The highest count was 118,400,000 microbes per c.c. and the lowest was 250,000 microbes per c.c. The above figures are only approximate, for as Savage says: "There are no nutrient media and no known conditions of growth which will allow all the bacteria in milk to develope." Without entering into a detailed discussion, it may be said that the count has a relative value when the samples are examined under identical conditions. The number of microbes varies a great deal, depending upon—(1) conditions of collection and transportation of milk; (2) time elapsing between the collection and the examination; (3) temperature.

The above figures show a much higher count in April and May when the heat is intense in Western India than in July and August, when it is cooler on account of the rains.

A few cows and buffaloes were brought to the Municipal Laboratory and several samples taken under aseptic precautions and examined immediately. The average of several samples was found to be 386 microbes per c.c. This shows the value of collecting milk with proper care.

It is open to question as to whether a legal bacteriological standard should not be adopted for milk in India, at least at present. Such standards exist abroad, particularly in American cities. Boston, for instance, has a legal standard of 500,000 bacteria per c.c. Further research is necessary before setting up a fixed standard. In the meantime, it is suggested that a tentative standard of one million microbes per c.c. should be set up for guidance in administrative work.

Lactose Fermenters in Milk.—About a hundred samples were examined at the Bombay Municipal Laboratory. In most of the samples lactose fermenters were found to be present in 0·000001 c. c. and more of milk, which would indicate much pollution.

In the samples collected under proper precautions lactose fermenters were entirely absent.

Are Tubercle bacilli conveyed by Milk in India?

Here, again, except in Bombay, no systematic investigation seems to have been carried out in India. Dr. Joshi reports that out of a total of 614 samples examined, acid fast bacilli were detected in only 47, giving 7·6 per cent., but in no single case were genuine Tubercle bacilli found by animal experiments. These results are confirmed by those of the Bombay Bacteriological Laboratory, Parel, where 100 samples of only cow's milk were examined for Tubercle bacilli but in no instance did the guinea-pigs develope Tuberculosis.

Judging from these results, it appears that Tubercle bacilli are rarely conveyed by milk in India.

PREPARATIONS FROM MILK.

Two of the preparations from milk, viz., *Mawa* and *Basundi* have been referred to above.

Cream.—When milk is allowed to stand undisturbed, the fat globules rise to the surface, as their specific gravity is lower than that of the entire milk. This supernatant layer of fat globules is called cream. Cream may also be obtained by mechanical means, by the use of a centrifugal separator, and this is done especially when cream is needed for commercial purposes. The colour of cream is yellowish white, due to lactochrome, but the commercial cream is sometimes heightened in colour by means of *annatto*. The amount of fat in domestically prepared cream varies according to the time which has been allowed for its separation; on an average it is about 18 per cent. but may range between 15 to 25 per cent. commercial cream is also sold in two grades according to the quantity of cream: "single," having about 25 per cent., and "double" having about 50 per cent.

Cream separated by mechanical means needs no preservatives, but domestic cream may, as the milk is exposed to air for a prolonged period, and besides lactic acid bacilli other bacteria may have grown in it : 1¼ grain of boric acid per ounce of cream is allowed by the Local Government Board in England.

'*Junket*' is prepared by the addition of rennet to milk and allowing it to stand until it coagulates. It is largely used in the sick room. When junket is broken up, the caseine separates and the substance is divided into whey and curds.

Whey is prepared by the addition of essence of rennet, or some weak acid, to some warmed milk and setting it aside until it is firmly coagulated. The coagulum is then cut into pieces and transferred to a muslin cloth and hung up and allowed to drain. Thus 1½ pints of milk yields about a pint of whey, which is collected as it drains through the muslin. It forms a pleasant, sweetish sour drink. It contains all the soluble proteins (1.24 per cent.) and milk sugar (4.45 per cent.). If added in equal bulk to cow's milk, it renders the composition of the milk nearly equal to that of human milk. Whey is recommended in Enteric Fevers, in catarrhal conditions of the alimentary canal and in many chronic renal and lung complaints.

Butter milk is the fluid which remains after butter is prepared and is as useful as whey in dietetics. It contains more fat and proteins than whey. Butter milk contains about 8 per cent. of milk solids. Butter milk prepared domestically is superior to that obtained from the separator, as it is acid in reaction owing to the development of lactic acid during the "ripening" of the cream. It is most useful in cases of Gastro-Enteritis as the casein forms into flocculi which are more readily digested in the stomach.

Fermented and Sour Milk.—When fresh milk is exposed to air, it absorbs certain acid-forming bacteria which multiply in the milk and render it acid. The most common of these is the Bacillus acidi lactici ; it produces enzymes which act on the milk sugar converting it into lactose and galactose and finally into *para* and *lacvolactic* acid.

The conversion of milk sugar into lactic acid goes on continuously until it attains a proportion of 1 per cent. when the acidity formed checks further multiplication of bacteria and secretion of enzymes and the milk coagulates spontaneously. Sour milk is largely used in Diabetes, as it is practically sugar-free, and in Gout as it reduces the formation of toxins from nitrogenous food. It is also useful in renal diseases. Sour milk, on account of the lactic acid it contains, exercises an antiseptic action on the alimentary canal and checks and arrests the growth of pathogenic and putrefactive bacteria. As developed in the sour milk, lactic acid has a more powerful action than the lactic acid artificially prepared. Metchnikoff strongly advocates the use of lactic acid organisms as a means of lengthening life by preventing fermentative changes going on in the alimentary canal. As a result of his teaching, artificially soured milk has come strongly in public favour and is being largely consumed. Several dairy companies sell sour milk thus prepared for immediate consumption ; it is prepared from pasteurised milk to which a culture of lactic acid organisms is added.

Ghee.—Ghee is clarified butter and is largely used in India for the preparation of various kinds of food and sweetmeats. It is also taken along with rice, *dhâls,* curries and other articles of food.

It is prepared either from the milk of the cow or the milk of the buffalo. The milk is first boiled and then curdled. After the lapse of about six hours the curdled milk is churned, a little water being added so that the butter floats to the top. The butter is then collected, washed in water, and boiled in an iron pan placed over an open fire. The effect of this is to melt the butter, the casein and water falling to the bottom. The floating ghee is then finally strained and stored in earthenware vessels or in tin cases.

In Bombay most of the ghee comes from certain places in Gujarat and Kathiawar, but there are certain premises in this City which are used for the manufacture of ghee. They are all situated in one locality on the ground floors of dwelling houses in a thickly populated area. There is no preliminary manufacture of butter on these premises.

Butter is brought in baskets from up-country and melted on the premises. The following regulations are in force in regard to the licensing of such premises.

(*a*) No portion of the premises on which the manufacture of ghee is licensed and no room situate over that portion of the premises shall be used for human habitation at night.

(*b*) All butter brought to the premises for being manufactured into ghee shall, until actually required for such manufacture, be stored in a room separate from the room in which the melting is carried on. Such separate storage room shall be airy and well ventilated ; it shall be entirely disconnected from any drain, nor shall any privy or water closet be allowed to ventilate into it.

(*c*) The floor of such separate storage room must be paved with impervious material to the satisfaction of the Commissioner.

(*d*) No butter shall be stored in passages, backyards, or spaces under staircases, or within twenty feet of a privy or water-closet.

(*e*) All stored butter must be kept in properly covered metal receptacles.

(*f*) The melting must be done in a properly constructed fire-place provided with a suitable flue.

(*g*) The ladles used for skimming the refuse matter from the surface of the melted butter must at all times be kept in a cleanly state, and must not be placed on the ground, but a suitable shelf or table must be provided for them in close proximity to the fire place, and such shelf or table must be maintained in a cleanly condition.

(*h*) The conditions which apply to the storage of butter shall also apply to the storage of prepared ghee, which may be kept in the separate storage room aforesaid.

(*i*) All coke, coal, or firewood, to be used in the process of melting butter, shall be kept in suitable receptacles and not loose.

Genuine ghee should be clear, white or slightly yellowish in appearance, and agreeable in odour. If it is dirty or has a rancid smell, it should be condemned.

A large percentage of ghee in the Bombay market is adulterated. The principal adulterants are ground-nut oil, cocoanut and cotton-seed oils and animal fat. Plantains, boiled potatoes and other vegetables, suet, &c., have also some times been found in ghee.

For preventing the adulteration of ghee and other articles of human food in the Bombay Presidency, an Act has been passed which is known as Bombay Act No. II of 1899. This Act is based on the provisions of the English Sale of Food and Drugs Act. For example, in the fraudulent substitution of the adulterated article for the genuine one, Section 3 (1) of this Act provides that "whoever sells to the prejudice of the purchaser any article of food which is not of the nature, substance or quality of the article demanded by the purchaser, shall be punished for the first offence with fine which may extend to 100 rupees, and for a second or any subsequent offence with fine which may extend to 500 rupees."

It is important to bear in mind that in proceeding under this Act all its requirements must be carefully observed. The article must be purchased by an officer duly empowered for the purpose by the Commissioner under Sec. 4 (1), and must be submitted to the Chemical Analyser to Government for analysis, whose certificate specifying the result of the analysis must be produced in Court. Moreover, the person purchasing the article must, on the completion of the purchase, forthwith notify to the seller his intention to have the article analysed by the Chemical Analyser, and offer to divide it into three parts to be then and there separated and sealed up—one to be delivered to the seller, one to be sent to the Analyst, and one to be retained by him. A person refusing to sell any article to any officer is liable to a penalty of fifty rupees.

No proceedings under this Act can be instituted without the permission of the Commissioner in the City of Bombay' and of the President or Vice-President in the case of mofussil municipalities. (Sec. 1 (5) (*d*)). Summons has to be applied for within a reasonable time from the date of the alleged offence, and in the case of a perishable article the application for summons must be within 28 days from the date of the purchase of such article.

For the present, the provisions of this Act only apply to ghee, but under Sec. 1 (5) (*b*) they can be made to apply to food of all kinds by means of a notification issued by the Governor-in-Council.

In practice the working of this Act has been found to be defective and it has not served the object for which it was passed.

By Section 4 of this Act, in Bombay, the Commissioner, or any officer empowered by him in that behalf, is the only person who can make the purchases necessary to test the genuineness of the article sold as ghee.

The officers usually empowered by him are the Executive Health Officer, the Health Officer's Assistants and the Deputy Health Officers.

These officers are well-known and any attempt to purchase ghee by them is usually met with the statement of the shopkeeper that the article sold is not pure ghee, and by this declaration he escapes prosecution.

In Section 3 (2), clause (*c*) of the Act, the following words occur :—" and before the sale thereof the seller has brought to the notice of the purchaser either by means of a label, distinct and legible, or otherwise, the fact that such matter or ingredient has been so added or mixed."

It is to be feared that but rarely is any intimation made to the general public that the article sold is not pure ghee, though, for obvious reasons, such a declaration is made to Municipal Officers suspected of purchasing samples. The word " otherwise " is objectionable, as the vendor has the option of labelling the tins, or giving verbal notice of non-guarantee of purity. Or yet, again, one frequently is confronted with a dirt begrimed board bearing the notice " Adulterated ghee sold here " on purchasing a sample. This board is supposed to be hung up in a conspicuous place, but this is rarely the case in practice, and it is only when suspicious of the intentions of the purchaser that the vendor draws attention to the notice which otherwise would escape observation.

Such a provision obviously leads to greater difficulty in the proper administration of the Act, and, in fact, practically nullifies it. For the better working of the Act, therefore, the words "or otherwise" should be deleted, and it should be made incumbent on the vendors to affix very conspicuous labels both in English and the vernaculars upon tins containing adulterated ghee; so that the public may see for themselves what they are buying and the Inspectorial staff cease to be hoodwinked. It is also necessary for Municipal Officers to have the power to purchase samples by the hands of a deputy, so that the vendors may not suspect the purpose for which the purchase is made until the transaction is completed.

Another difficulty, and one which adds considerably to the expense of administering the Act, is the comparative immunity which is at present enjoyed by the wholesale dealers who are the principal offenders. At present, if a small quantity of ghee is asked for from them for the purpose of analysis they will not sell it. A whole tin must be purchased, and the subsequent division of the contents of this tin into three parts and the sealing and labelling of the vessels containing them presents some difficulties and leads to unnecessary waste and expense.

In this connection, it would be as well to follow the procedure of the Margarine Act, 1887, Section 9, and compel all manufacturers of artificial ghee to be registered with the Local Authority (in Bombay, the Municipality), and in addition, adopt the procedure of Section 7 of the Food and Drugs Act, 1899, which compels wholesale dealers in Margarine—(in India substitute artificial ghee) as well as manufacturers to be registered.

This Section (7) not only compels registration with the Local Authority but also insists on the proper keeping of a register showing the name and address of any person to whom any Margarine (in India, artificial ghee) was sent. Municipal Officers duly authorized should have power to enter factories where artificial ghee is made and inspect this register.

Regulation and Control of the Sale of Milk.

The very unsatisfactory state of the milk supply of large towns in India has long been realized, but it is only within the last few years that the subject of improving it has received the attention which it deserves.

In Bombay and other large Indian towns dairies have been established by private enterprise, in which a fairly good attempt is made to handle milk by Western methods. But these establishments cater for the well-to-do classes, who alone can afford to pay the high prices charged for milk at these places. The problem which therefore usually confronts the Health Officer in India is how to obtain a reasonably pure and wholesome milk-supply from indigenous agencies, *viz.*, the *gowli.*

It is well-known that milk is stored by these *gowlis* in dirty hovels, the brass milk-vessels undergo a process of so-called cleaning by being scrubbed with mud obtained from filthy sources, and milk is carried long distance in open cans with a wisp of dirty straw floating in it to prevent spilling.

The legal provisions existing in the City of Bombay Municipal Act have been found defective in remedying these glaring evils and for the better regulation of the milk trade, a new section has recently been inserted in the Act. It is Section 412-A and runs as follows:—

"No person shall without or otherwise than in conformity with the terms of a license granted by the Commissioner in this behalf—

(*a*) carry on within the city the trade or business of a dealer in or importer or seller or hawker of milk;

(*b*) use any place in the city for the sale of milk."

In connection with the above Section of the Act, the following regulations have been framed and will form the conditions of the license to be granted to a milk-seller.

(*a*). Under clause (*a*) of Section 412-A :—

1. All dealers, importers, sellers or hawkers of milk in public places must have their names and addresses marked upon the vehicles and cans.

2. All milk exposed for sale must be declared as pure buffalo or cow milk or skimmed milk.

3. No dealer, importer, seller or hawker of milk shall cause or suffer any cow or buffalo belonging to him or under his care or control to be milked for the purpose of obtaining milk for sale —

(*i*) unless, at the time of milking, the udder and teats of such cow or buffalo are thoroughly clean ;

(*ii*) unless the hands of the person milking such, are thoroughly clean and free from all infection and contamination ; and

(*iii*) unless the milk receiving vessel is thoroughly clean and rinsed with clean boiling water.

4. Every dealer, importer, seller or hawker of milk shall take all reasonable and proper precautions in connection with the collection, storage and distribution of the milk, and otherwise to prevent the exposure of the milk to any infection or contamination.

5. He shall not keep milk for sale, or cause or suffer any such milk to be placed in any vessel, receptacle or utensil which is not thoroughly clean.

6. He shall cause every vessel, receptacle or utensil used by him for containing milk for sale to be thoroughly cleansed with steam or clean boiling water after it shall have been used, and to be maintained in a constant state of cleanliness.

7. He shall not convey any milk for sale or distribution in open vessels, but the latter shall be provided with proper close-fitting covers under lock and key and a tap at the

lower end through which the milk shall be retailed to the customers. If the milk is distributed in cans they shall also be provided with properly fixed covers.

8. He shall not at any time mix with other milk, or sell or use for human food the milk of any cow or buffalo which may be suffering from Tuberculosis, Rinderpest, Foot and Mouth Disease, or disease of the udder which may be certified by a Veterinary Surgeon to be tubercular.

9. A dairyman or milk seller shall not permit any person suffering from any dangerous or infectious disease to sell or assist in the sale or distribution of milk, but shall at once cause every such person to be removed from the vicinity of the premises in which milk is stored or sold.

10. A person engaged in selling or assisting in the sale or distribution of milk shall not knowingly come in contact or communication with any person suffering from any dangerous or infectious diasease.

(*b*). Under clause (*b*) of Section 412-A:—

1. He shall not keep any milk intended for sale in any room or place where it would be liable to become infected or contaminated by impure air, or by any offensive, noxious or deleterious gas or substance, or by noxious or injurious emanation, exhalation or effluvium.

2. He shall not keep any milk intended for sale in any room used as a kitchen or as a living room or in any room where any other trade is carried on, or in any room or building, or part of a building communicating directly by doors, window or otherwise with any room used as a sleeping room, or in which there may be any person suffering from any infectious or contagious disease, or which may have been used by any person suffering from any such disease and may not have been properly disinfected.

3. He shall not keep any milk intended for sale in any room or building or part of a building in which there may be any direct inlet to any drain, or which opens on to a gully or in which a privy or water-closet opens directly.

4. He shall at all times protect the milk, which is intended for sale, from dust and flies by providing suitable covers to the milk-vessels.

5. He shall not retail the milk to his customers by dipping his hands into the vessels, but the latter shall be provided with taps at the lower end through which the milk shall be drawn.

6. He shall cause the floor and drain of every such room or place, and every counter, shelf or bench on which milk-vessels are kept, to be washed and thoroughly cleansed daily.

7. He shall cause every vessel used in his milk-shop to be rinsed with boiling water and thoroughly cleansed before and after use.

8. He shall cause the floor of every such milk-shop to be paved throughout with suitable impervious material approved by the Commissioner, and the paving shall be so sloped as to ensure effectual drainage having a gradient of not less than 1 in 30.

9. He shall cause every part of the internal surface of the walls and ceiling of every such milk-shop to be thoroughly lime-washed twice at least in every year, or oftener if so required by the Commissioner.

PRESERVATION OF FOOD.

The usual methods are by cold, drying, salting, smoking, heat and exclusion of air by tinning, and by the use of chemical substances.

Preservation by Cold.

This can be done in two ways, either by freezing the flesh and keeping it so ; or (2) by keeping it in a chamber, the temperature of which is at or just below freezing point.

Frozen meat is often very tender and of excellent quality, though sometimes it is lacking in flavour. The juice is less abundant and less red in colour than that from fresh meat, and, according to Maljean, the corpuscles in the juice of the former are more or less distorted in form and decolorised. Bacteria in general offer great resistance to cold, which, while not killing them, prevents their development; this at any rate is more particularly the case in regard to the putrefactive bacteria. The flesh has a uniform pink appearance. The fat is of a dead white colour. Refrigerated meat can be recognised by the fact that the fat is pinkish in colour, while the outside of the meat presents a dead white colour. When frozen meat thaws, there is much oozing of fluid, the flesh has a parboiled appearance and the fat has a dead white colour. It is important, especially if the piece is a large one, to ascertain the condition of the interior as the outside may be apparently allright and yet the interior be decomposed. This can be done by inserting a knife or thick skewer and, on withdrawal thereof, noting the presence or absence of any offensive smell. This should be done especially in the neighbourhood of joints and bones, as putrefaction sets in early there.

On removing the cloth, in which refrigerated meat is wrapped, a disagreeable smell may be noticed. The meat should not be too hastily condemned on this account, as the smell may be due to the wrapper and not to any deeper-seated trouble. Klein has recently published a report on the nature of the black spots occasionally seen on chilled beef. It appears that the meat shipped to England from the Argentine occasionally developes circular black spots which may be in groups or isolated. On the lower or thin parts they are seen in the fascia, and on the thick parts in the fatty portions and in the fat belonging to the inner surfaces of the flanks. According to Klein they are due to a mycelium of a fungus of the nature of an oidium which he has proposed to call Oidium Carnis. It forms oval gonidia either by short lateral branches of the free hyphæ or along and at the ends of the superficial threads in the fatty tissues. The oval gonidia are capable of multiplying in the manner of yeast cells. He is of opinion that the material of the black spots is harmless to the animal body, a view which is confirmed by direct experiment; further, that the presence of the mycelium does not in any way alter the normal character of the tissue elements themselves, either those among which the mycelium is situated or those beyond its extension.

Preservation by Drying.

Flesh can be dried either by the sun or by artificial heat. When so treated, much water is lost and consequently the flesh does not offer much inducement to bacteria to flourish. If kept dry, such meat will last a long time.

Preservation by Salting.

Brine is usually composed of saltpetre 1 part to salt 32 parts and sugar 2 parts. This latter is added in order to hinder putrefaction.

The salt acts by removing water from the flesh and also as a faint antiseptic. As it frequently causes discoloration, potassium nitrate (saltpetre) is added. Care should be taken not to add too much, as evidence exists to show that saltpetre has the power of inducing irritation and inflammation of the mucous membrane of the intestine. The nutritive value of flesh when salted is very much lessened. One must examine the meat very carefully to see if any has gone bad, which occurrence would be indicated by the meat being paler than usual, with green patches here and there, and the presence of an unpleasant smell. Streptococci and the Tubercle bacillus can retain their virulence for months in salted flesh, so also the spores of Anthrax bacilli. Cysticerci, etc., are not killed by salting.

The brine is sometimes poisonous, due apparently to the products of the decomposition of animal substances which have passed into it. This occurs in cases where the brine has been used for several relays of meat.

Instead of curing meat by placing it in brine, the same object can be effected by what is known as dry salting. In this the flesh is treated by repeated applications of salt and saltpetre to the external surface. Klein has recently discussed the nature and cause of taint in miscured hams. The hams examined were dry-cured only, no other method of salting, injection or pickling in fluid being used. The hams had a distinctly putrid smell, the muscles were more or less discoloured, in the slightly tainted part the characteristic red tint of well-cured muscle had given way to a pale or dirty grey tint, while in the strongly tainted parts the colour was dirty grey to green, and, moreover, the muscle tissue was swollen and soft like jelly. On microscopical examination small linear clumps of tyrosin crystals were found, many being seen near blood vessels. The muscle fibres lose their transverse striation, swell and break down and contain numerous empty spaces (gas bubbles). These all indicate putrid decomposition of the proteid constituents of the muscle. The reaction is alkaline to litmus. In all cases the decomposition is most pronounced at and around the knee. The taint starts here and gradually progresses towards the femoral and gluteal regions. In badly miscured hams the condyles of the femur, patella, condyles of the tibia, crucial ligaments, semilunar cartilages, connective tissues, tendons and muscles adjoining the capsule are green and very putrid to the smell. The essential cause in all hams examined was one and the same species of cylindrical microbe found in great numbers in the tainted part and proportionate in number to the degree of taint. All the affected parts contain the organisms. The free surfaces of all parts within the articulation are covered with a slimy, moist film which, when examined under a microscope, is seen to be composed of a continuous mass of the microbe which has been named the Bacillus Fœdans.

Preservation by Smoking.

This method acts mainly by reason of its drying effect and to a lesser extent on account of the antiseptic action of some of the constituents of the smoke. It does not kill many of the bacteria but retards their development. Subsequent to smoking certain articles now appear to be subjected to an artificial colouring process. Smoked haddock and catfish are dipped in a dye, not annatto, but one of the coal tar derivatives somewhat of the methyl orange type largely used in colouring sweetmeats and imitation Demerara sugar. While such may not be actually poisonous, there are grave objections to the use of such dyes when other and innocuous materials are at the disposal of the manufacturers.

Preservation by Heat.

Steam is used to sterilise the article, which is then placed in tins or in glass or earthenware jars.

Poisoning, as the result of eating tinned goods, may arise from (1) decomposition of the flesh owing to imperfect sterilisation, or from incomplete sealing of the tin ; (2) the flesh having been poisonous originally, as is sometimes seen in fresh flesh from exhausted animals and in certain fish ; or (3) metal having been dissolved from the can or from the lead used to seal it.

The most dangerous tinned foods are those containing much moisture, *e.g.*, milk, salmon, lobster and mixtures of meat and vegetables. The simpler the preparation the better it stands the climate. Beveridge states that in warm climates no tinned meat stored in the open, exposed to varying temperatures and the sun and rain, should be kept for more than one year.

Metal is more likely to be taken up by the acid food stuffs *e.g.*, jams, fruits and vegetables. On opening certain tins, *e.g.*, of marmalade, rhubarb, tomato soup, etc., a blackened appearance may be noticed; this is due to the action of the vegetable acids on the tin plating : if only slight, and there be no fermentative changes present, it may be neglected.

A tin, the contents of which are sound, usually has slightly concave ends, owing to the partial vacuum caused during sterilisation. The jelly surrounding the flesh should be solid ; if it is found in a liquid state it indicates that decomposition has probably occurred.

Dented tins may be passed, if they are intended for early consumption ; otherwise, if kept too long, they are apt to lust and perforate and so prepare the way for the decomposition of the contents.

Bulged or blown tins can be tested by puncture under water. If necessary the tins may first be boiled for an hour, which act causes the ends to bulge, and if the contents are unsound the convexity due to the contained gases is marked.

Re-soldering of the tins should be most carefully looked for, as this is suspicious of blown tins having been tapped and resealed. The presence of moulds is sufficient to condemn the contents, because, even if not definitely harmful in themselves, they indicate faulty sterilisation, and, moreover, they impart an unpleasant taste to the contents, and may cause Diarrhœa in the consumer.

Metallic Contamination:—All kinds of tinned foods are liable to this ; the amount depending on the length of time in the tin. Lead, if present, is generally there, as the result of careless soldering. Copper may be present owing to the preparation of the article in vessels of that metal, or it may have been present in the food itself originally, *e.g.*, in certain shell fish, but more frequently it is present, due to the introduction of salts of copper for the purpose of preserving the green colour of vegetables, *e.g.*, peas, spinach, asparagus, etc. Dr. Buchanan and Dr. Schryver, in a report to the Local Government Board on "The presence of tin in certain canned foods," submitted in December 1908, make the following statements :—"Practically all foods canned in the ordinary way become to some extent contaminated by tin. The metal is taken up to a greater extent by meat extracts and essences than by other meat foods due to the acidity present in these preparations. Certain canned fruits and vegetables, *e.g.*, peaches, cherries, apricots, pineapples, tomatoes, asparagus and also canned soups, *e.g.*, tomato soup, are specially liable to take up tin. The tin may penetrate into the substance of solid foods, and, in the case of tinned foods which are of both liquid and solid portions, the metal after solution in the liquid portion of the contents may, in the course of time, become absorbed in or chemically combined with the solid part.

"As time goes on the quantity of tin taken up increases, but there is reason to believe that in the case of solid acid food-stuffs the rapidity of solution is somewhat slower in the later period than in the first few months after canning.

"Much depends on the quality of the tin plating ; when the thickness thereof is reduced to a minimum, then a comparatively small amount of erosion will, in parts, expose the steel or iron basis of the can and thus permit of an electrolytic action, resulting in acceleration of the further solution of the tin.

"If solder, which contains both tin and lead, is allowed to gain access to the interior of the can, a very conspicuous solution of tin may take place; this results in a double risk of poisoning from tin and lead."

Ungar and Bodlander experimenting on animals found that minute doses of tin salts, when introduced into the body by subcutaneous injection and continued over a considerable period, produce a marked effect on the general nutrition and in particular affect the nervous system causing paralysis and other symptoms.

Dr. Schryver refers to a recorded case of chronic tin poisoning in man in which nervous symptoms occurred similar to those experimentally produced in animals. In this case, however, the tin was not taken up by the alimentary canal and he has not yet succeeded in tracing instances in which similar symptoms have followed the continued ingestion of small doses of tin along with food. He also experimented on himself, and is of opinion that there is not much probability of serious risk of chronic poisoning by tin as a result of a diet which consists largely of tinned food, even when continued over a long period of time.

The greatest danger from tinned foods is from decomposition of the contents.

Preservation by means of Chemical Substances.

The preservation of food by chemicals occurs on a very large scale at the present day. The substances most usually employed are boracic and salicylic acids, formaldehyde, sulphur dioxide, and sulphites, benzoic acid and sodium benzoate, the two latter being largely used in preserving cider, perry, grape juice, mince meats, jellies, jams and catsups. They may cause discomfort and malaise, nausea, headache and a weakness and a burning or irritating sensation in the œsophagus, hunger, indigestion and loss of weight. When added to food, both must be considered injurious to health.

Boracic Acid and Borax are very largely used as preservatives of hams, fish (especially potted fish), sausages, milk, cream, butter, brawn and many other food substances. They are cumulative drugs and are eliminated but slowly from the system. Much conflicting evidence exists in regard to the influence of these drugs on health. Halliburton states that the addition of these drugs to milk in any quantity is harmful as it interferes with the process of digestion by the natural gastric juices, and the lime salts in the milk are rendered insoluble. It is especially dangerous to any one suffering from kidney disease, as it is by that organ that it is excreted. In pregnant women it may cause abortion. Kenwood holds similar views, and states that it produces headache, indigestion and flatulence.

Sulphurous acid and its salts, the sulphites of calcium, sodium and magnesium are largely used to preserve meat, potted meats, sausages, perry, cider, wines, dried fruits, syrups and molasses. In the case of meat the sulphite is only partially decomposed and expelled by cooking. In the case of wines, the cleansing of the barrels by the action of burning sulphur prevents those secondary changes which would otherwise produce the ripening of the wine. In the manufacture of syrups and molasses, it is quite customary to expose the freshly expressed juice of the cane to sulphur fumes. The SO_2 forms more or less stable compounds with the components of the juice and a part of it passes into the finished product, especially in the case of molasses, low grades of which contain extraordinarily large quantities of free and combined sulphur dioxide. Apricots, peaches, pears and other fruits are frequently sulphured before desiccation in order to produce a clear and intense yellow colour, to prevent fermentation and decay, to conceal decayed portions of the fruit, to protect from insects and their larvæ and to hasten the drying process. It is worthy of notice that highly sulphured fruits are preserved with a lower degree of desiccation than those that are not sulphured. It is not difficult in this way to preserve a water content of 30 per cent. in the finished product, thus enabling the manufacturer to obtain a greater yield from a given weight of raw material.

Wiley carried out a series of experiments on students who observed their usual and regular hours of sleep, work and exercise, etc. The preservative was administered in two forms: sodium sulphite in capsules was given to one-half of the students, and sulphurous acid to the other half in their drinking water. The average daily consumption for 20 days was 0·392 to 0·628 gramme of sodium sulphite or 0·213 to 0·343 gramme of sulphur dioxide. The results showed that sulphurous acid and its salts in the free state produce harmful effects, metabolism being disturbed and the health, particularly digestion, being injuriously impaired. In the great majority of cases headache, sensations of dizziness and occasional nausea, indigestion, pains in the stomach, exhaustion, weakness and in some cases palpitation of the heart and other unfavourable symptoms were noticed. Of these the most prominent symptom was headache. Abundant evidence was obtained to show that these preservatives unfavourably influence the metabolism. The assimilation of food materials containing organic phosphorous was retarded, while the sulphur catabolism was increased. The sulphur balance sheets showed that the kidneys were called upon to remove from the body nearly all, if not all, the added sulphur in the form of sulphuric acid or its salts. Microscopic examinations showed an increase in the number of crystalline and amorphous bodies in the urine, indicating the unusual demands upon the kidneys. The habitual overworking of these organs might be expected, sooner or later, to produce lesions possibly of an incurable type. It was also observed that there was a marked tendency to albuminuria. The most important results of these experiments relate to the reduction in the quantity of hæmoglobin and in the number of red and white blood corpuscles, particularly the latter, under the action of sulphurous acid and its salts. The administration of a substance which diminishes to a notable extent these important constituents of the blood is regarded as highly prejudicial to health. Throughout the experiments, the variations of the metabolic functions from the normal were never of a character favourable to a more healthy condition of the system. The evidence all points to the fact that sulphurous acid and its salts are purely drugs having no value as foods and exerting nothing but harmful effects. The conclusion is, therefore, drawn that the use of sulphurous acid and its salts in any quantity or for any period as preservatives of foods should be avoided.

Formaldehyde has been used for preserving nearly every variety of perishable foods. Solutions of formaldehyde and special preparations containing it are used. It is a very powerful disinfectant and may retard digestion even when largely diluted and, as it readily combines with the proteid constituents of foods, it forms a compound which is less digestible than the original substance. Schryver found that formaldehyde could be recovered from not only various parts of the surface of the meat, but also from parts below the surface,especially where the muscles had not been covered by connective tissue or fat. He found that boiling and roasting appeared to reduce or even remove the formaldehyde; grilling however appeared to make it penetrate further into substance. Articles like minced meats, fish, kidneys, etc., which expose a large surface in proportion to weight, cannot be exposed to fuming in formalin safes without absorbing a relatively large quantity of the drug.

Salicylic Acid is frequently found in beer, wines, milk, jams. A few remarks may be made at this stage on the artificial colouring of food-stuffs. Many substances are used to produce a good colour in the materials to be sold, *e.g.*, analine dyes in Demerara sugar, black mallows, cochineal, fuchsin, indigo, Campeachy and Pernambeco wood, beet juice, raspberry and cherry juice in wines, coal tar dyes, salts of copper and chlorophyll for peas, peroxide of nitrogen in the artificial ageing of flour. Armenian bole, the colouring principle of which is red oxide of iron, is occasionally used for sausages, potted meats, anchovy and bloater paste, sweets, etc., but this, along with logwood and camwood which were formerly used for the purpose, are now being superseded by red coal tar derivatives.

Graphite is occasionally used to improve the colour of tea and peppercorns. Turmeric, oxide of iron, Prussian blue and caramel are used to colour tea and coffee.

For dairy produce the most commonly used colouring matter is annatto, a vegetable extract from Bixa Orellana. This and certain other yellow colouring agents of vegetable origin, *e. g.*, saffron, turmeric, have generally been considered harmless in the quantities used; but these substances are now being gradually ousted by yellow coal tar derivatives, the action of which upon the human system is not fully known. A large number of margarines are similarly coloured. The coal tar yellow most frequently used is known as butter yellow, its chemical name being dimethyl-amido-azo-benzene. It is generally supplied to the trade ready dissolved in oil, either cotton seed, rape, linseed, or sesame oil. Tropeolins, which are sulphonated azo-derivatives of coal tar, are also coming into use. Sweets and confectionery are often coloured yellow by compounds of barium, arsenic, antimony and lead ; compounds of arsenic and copper are used to give a green colour or compounds of barium and zinc to confer whiteness, and Prussian blue to produce a blue colour. Coal tar products are largely employed in almost every class of food and drink, chiefly, however, in the preparation of jams temperance drinks, sweets and confectionery, fruit jellies, syrups and cordials and sugars. Exhausted tea leaves are sometimes treated with catechu to give them a fresh and new appearance.

The English Departmental Committee appointed to inquire into the use of preservatives and colouring matters in food in 1901 recommended as follows :—

(1) That the use of formaldehyde or formalin or preparations thereof in foods or drinks be absolutely prohibited and that salicylic acid be not used in a greater proportion than 1 grain per pint in liquid food or 1 grain per pound in solid food. In every case its presence must be declared.

(2) That the use of any preservative or colouring matter whatever in milk offered for sale in the United Kingdom be constituted an offence under the Sale of Foods and Drugs Act.

(3) That the only preservative which it shall be lawful to use in cream be boric acid or a mixture of boric acid and

borax, and in an amount not exceeding 0.25 % expressed as boric acid and the amount of such preservative be notified by a label on the vessel containing the cream.

(4) That the only preservative to be used in butter and margarine be boric acid or a mixture of boric acid and borax in an amount not exceeding 0.5% expressed as boric acid.

(5) That in the case of all dietetic preparations intended for the use of invalids or infants, chemical preservatives of all kinds be absolutely prohibited.

(6) That the use of copper salts in the so-called greening of preserved vegetables be prohibited.

The United States Department of Agriculture has issued a provisional decision on the question of the use of dyes and chemical preservatives in foods. It has been determined that in general no drug, chemical, or harmful or deleterious dye or preservative be used. Common salt, sugar, wood smoke, potable distilled liquors, vinegar and condiments may be used. Saltpetre is permitted pending further inquiry. No prosecution is to be instituted in the case of the application of the fumes of burning sulphur (SO_2), as usually employed in the manufacture of these foods and food products which contain aldehyde, sugars, and so on, with which sulphurous acid may combine, if the total amount of sulphur dioxide in the finished product does not exceed 350 milligrammes per litre in wines or 350 milligrammes per kilogramme in other food products. Of this amount 70 milligrammes may exist in the free state. Foods and food products packed or manufactured during the season of 1907, which contain sodium benzoate in quantities not exceeding one-tenth of one per cent., or an equivalent of benzoic acid, will be permitted, provided it has been customary to use this preservative in such foods. The label of every package containing sulphured foods, or foods treated with benzoic acid, or benzoates must bear a statement to that effect. No statement is allowed on the article to the effect that the article is guaranteed to conform to the requirements of the Foods and Drugs Act. The use of any dye, harmless or otherwise, to colour or to stain a food in a manner calculated to conceal damage or inferiority, is specifically prohibited, and the use in food for any purpose of any mineral dye or any coal tar dye, except certain ones which are listed, will occasion ground for prosecution. Pending investigations proceeding, certain coal tar dyes are permitted, provided they bear a guarantee from the manufacturer that they are free from subsidiary products and represent the actual substance the name of which they bear. The list includes the following colourings:—Red shades—amarnath ponceau erythrosin. Orange shade—orange I. Yellow shade—naphthol yellow S. Blue shade—indigo di-sulpho acid. So far the question of the use of copper salts for colouring peas, etc., has not been finally settled, but for the present all vegetables, which are greened with copper salts and which do not contain an excessive amount of copper, will be admitted to entry, provided that the label bears a statement that copper salts have been used.

The Swiss and German Governments have prohibited the use of chemical agents in the preservation of meat and meat products with the exception of salt and saltpetre.

PRESERVATION OF MILK.

Pasteurisation.

Pasteurisation is a term applied to a process of rendering milk, which has been or may have been bacterially polluted, safe for consumption without at the same time depriving it of any valuable nutritive properties ; in other words, milk is raised to a certain temperature and maintained at that temperature for a certain period sufficient to kill all pathogenic and harmful bacteria—at the same time preserving all the properties of normal fresh milk. Opinions differ as to the length of time the milk should be exposed to a certain specified temperature, and accordingly two types of Pasteurisers have been devised :—(1) Continuous flow (flash) pasteuriser in which the milk is heated to a certain temperature and exposed to that degree only for a moment ; (2) while in the other, a "retainer pasteuriser," the milk is heated to a lower temperature and kept at that degree for a definite period, generally not exceeding 25 minutes. From the hygienic and domestic point of view the latter appears to be the better, while the former is better for trade purposes, since a large quantity of milk can be treated in a given time. Bacteria which live and flourish in milk have a certain thermal death-point. These die when milk attains a certain heat and the bacilli are exposed to that heat for a sufficient period. The most resistant of all the bacilli found to flourish in milk is the B. tuberculosis, and it has been found by experiments that B. tuberculosis is killed if exposed to 71° C. (160° F.) for a minute, or to 60° C. (140° F.) for 20 minutes; but as there is a disagreement among experts as to the degree of thermal death-point, it is safer for practical purposes that a few degrees higher should be adopted—77° C. in continuous flow (flash) pasteuriser for one minute, or 65° C. for about 20 minutes in the "holder" or "retainer." Although most of the organisms are destroyed by this process, there is no evidence to show if the toxins produced by them are also destroyed. It must be borne in mind that pasteurised milk may be infected with pathogenic bacteria or other toxin-forming organisms in the process of storing, keeping or handling pasteurised milk. Further, pasteurisation may alter the chemical and physical composition of milk and thus render it less digestible or nutritive. It has been found that at 60° C. milk remains unchanged, but at 71° C. its properties are affected and cream will not rise as in fresh milk. Chemical preservatives are often added to milk with a view to prevent bacterial growth, or keep it in an apparently unaltered condition for a prolonged period. This is chiefly done for commercial purposes. The chemicals most frequently used are boric acid and formaldehyde. Others however are sometimes added, such as benzoic, salicylic acid, soda bicarbonate and hydrogen peroxide. It has been found, however, that these preservatives are added in variable quantities and in almost all cases more in amount than actually required to preserve the milk for 24 hours. All such preservatives are positively harmful and dangerous to health, especially to invalids, children and infants. It has been found by experience that chemical preservatives are totally unnecessary for keeping milk for 24 hours, and the knowledge that these preserve milk serves the milk supplier's purpose of selling preserved stale milk which may contain pathogenic bacteria and toxins and forms also an incentive for the supplier to collect milk under conditions of neglect and dirt.

Refrigeration.

In this method if milk is kept between 0°C. to 10°C. the bacteria in the milk are not killed, but do not multiply to such extent as they would in ordinary temperatures. In consequence it would prevent the increase of toxic products. It is therefore obvious that milk should be cooled at the place of collection and not after its transit to the milk vendors. Refrigeration is now done in ocean-going steamers, where refrigerating chambers are provided and the milk is frozen in blocks in ice-making machines.

Sterilisation.

This method cannot be adopted for commercial purposes, for to sterilise milk it would be necessary to raise the temperature to a higher degree than that of boiling water by heating it in sealed chambers under steam pressure. Such heating would kill all germs and their spores but would alter materially the taste and appearance of milk. It has been found by analysis that ordinary sterile milk (*sic*) sold in the European markets is not sterile at all, but contains many varieties of bacteria.

For domestic purposes milk, if boiled, would keep for a certain length of time. The boiling point of milk is 97° C. and if this temperature is reached by gradual and slow heating, it will destroy all pathogenic germs and the milk may be called bacterially safe to consume. It is said, however, that milk alters materially by boiling both in taste and other properties. The following are the changes which occur :—

(1) The cream does not rise ; (2) all gases are expelled ; (3) salts of magnesium and calcium are precipitated ; (4) the lactose is burnt or "caramelised" and becomes brownish in colour ; (5) the milk acquires a peculiar taste and kills all the milk ferments present in milk ; (6) the germicidal power of milk is lost ; (7) lecithin and nuclein are said to be decomdosed and the normal emulsion of fat globules is disturb-

ed so that cream does not rise. It has however been found experimentally that boiled milk does not suffer as regards its digestibility or nutritive value.

Condensation.

Condensed milk may be of whole or skim milk, evaporated to one-third its bulk. It may be unsweetened, or sweetened with addition of cane sugar. To milk is added one-eighth of its weight of cane sugar ($1\frac{1}{4}$ lbs. per gallon) and dissolved by moderate heat. This is then transferred to a vacuum pan, where it attains a temperature of 60° or 70°C., and condensed to one-third its original bulk.

The chief feature of this process is that the air inside the oven or pan is kept in a state of rarefaction by means of a pump, so that the milk shall boil at a low temperature, and not cause any "browning" and other changes incident to exposure to 100°C. (212° F.) and upwards. During the process all the gases and air are expelled, and it boils without frothing over.

Unsweetened condensed milk is prepared by placing the milk in a tank and heating by a hot water jacket; gradual evaporation occurs and it is reduced to the required consistence. The milk is then canned and hermetically sealed and lastly exposed to a temperature of 280°F. to ensure perfect sterilization. Condensed milks should contain, as they are reduced to one-third of their bulk, 10 per cent. of fat and 25 per cent. of solids not fat. The sweetened variety is generally used by the public. No preservatives are necessary as the low proportion of water and large percentage of sugar do not favour bacterial growth. Unsweetened condensed milk can be used like fresh milk in many ways. Since its bulk is reduced from 3 to 1, it should be raised to that by the addition of twice its volume of water. It can be used in cookery like ordinary milk in places where fresh milk is not available. Condensed milk is not suitable for infants, as during its preparation it loses many of its characteristics, especially by the destruction of lecithin and the bactericidal properties possessed by fresh milk. Afghanis and Bhokaris carry with them while going on long pilgrimages small square cakes of desiccated milk; these are prepared by slow evaporation of milk at low temperatures to a firm consistency, then pressed and dried and cut into small square cakes.

Powdered milk is also now being used. It is prepared by evaporating milk in a water bath until the required consistency is reached; this is then transferred to a rolling drum through which hot air is driven until it becomes a semi-solid mass. It is then pressed through a sieve, and the granules thus obtained are then reduced to powder. The powdered milk serves all the purposes of fresh milk and is very convenient for transport.

The Local Government Board, England, have now issued orders *re.* the use of preservatives in milk, largely based on the recommendations of the Committee which have been enumerated above. The regulations as they apply to cream are more stringent than the recommendations. They came into force on June 1, 1912, with the exception of the provision relating to the labelling of preserved cream, which took effect on January 1st, 1913.

They provide that no person shall aid, or order, or permit any other person to add any preservative substance to milk intended for sale for human consumption and that no person shall sell, or expose, or offer for sale, or have in his possession for the purpose of sale, any milk to which any preservative substance has been added in contravention of subdivision 1 of this article. The expression milk includes skimmed, separated, condensed and dried milk, but as the traffic in condensed milk would be seriously impeded if the use of sugar were disallowed, it is provided that neither cane nor beet sugar shall be regarded as a preservative or a thickening substance.

With regard to cream, the regulations provide that no person shall add, or order or permit any other person to add, or sell (*a*) any thickening substance to cream or preserved cream, (*b*) any preservative substance to cream containing less than 40 % by weight of milk and fat, (*c*) cream containing 40% or more by weight of milk fat any preservative substance other than boric acid, borax or a mixture of those preservative substances or hydrogen peroxide in amount not exceeding 0.1% by weight, in any case in which the cream is intended for human consumption.

Dealers in cream preserved in a manner which does not contravene the above regulations will be required, by means of labels on the receptacles, to declare that the cream is preserved and to state the name of the preservative.

CHAPTER VI.

INFECTIOUS DISEASES AND THEIR PREVENTION.

Under the heading of 'Infectious Diseases' are included diseases communicable from man to man and from animal to man.

The list of such diseases in India includes many which are not met with in European countries. A knowledge of the cause of and the way in which such diseases are communicated is a necessary part of the education of the Sanitary Official whether he be the Health Officer or the Sanitary Inspector.

LAWS FOR PREVENTION AND NOTIFICATION OF INFECTIOUS DISEASES.

The Acts relating to the prevention of infectious diseases in England are:—

The Notification of Infectious Diseases Act, 1889, and the Infectious Diseases Prevention Act, 1890, Tuberculosis Act, 1909. The first deals with the compulsory notification, by a medical practitioner to the Medical Officer of Health, as soon as he becomes aware of any such case and by the head of the family or nearest relative, and relates to Small-pox, Typhoid (Enteric), Tuberculosis, Typhus, Cholera, Scarlet Fever, Diphtheria, Croup and Erysipelas and sometimes Measles, Relapsing Fever, Puerperal Fever and Phthisis, for which a fee of 2*s.* 6*d.* is paid for every notification by a medical man in practice and 1*s.* 6*d.* for every case occurring in a public institution. The second relates to the prevention of the spread of disease by milk and the disinfecting of premises and clothes and the letting of houses in which cases of infectious diseases occurred and the disposal of bodies of persons dying of infectious disease.

The Public Health Act, 1875, also provides for the provision of hospital accommodation for infectious diseases and the compulsory removal thereto of cases of such diseases.

In 1909 the Pulmonary Tuberculosis Notification Act came into force in England.

The Local Government Board may at any time declare other diseases notifiable and issue special orders for the control of Plague, Cholera, etc.

In India the laws relating to the prevention of infectious diseases are framed on the above but the wording is different and the diseases are not always specified, the words " any dangerous disease " being used.

Sections of the Bombay Municipal Act relating to Infectious Diseases.

421. Every medical practitioner who treats or becomes cognizant of the existence of any dangerous disease in any private or public dwelling, other than a public hospital, shall give information of the same with the least practicable delay to the Executive Health Officer. The said information shall be communicated in such form and with such details as the Executive Health Officer, with the consent of the Commissioner, may from time to time require.

No. $\frac{\text{IV}}{6}$

(*Duplicate.*)

Name of the Street________________

No. of House________________

Name of Patient________________

Sex________________

Age________________

Disease________________

Date________________

Medical Practitioner.

Form of Notification in Bombay City.

NOTIFICATION OF INFECTIOUS DISEASES. (Original.)

Information for the Executive Health Officer, Bombay.

Diseases to be notified are Small-Pox, Plague, Cholera, Relapsing Fever, Enteric Fever, Diphtheria, Tuberculosis.

*Bombay, dated*________________191 .

Name of Street.	No. of House.	Name of patient.	Sex.	Age.	Disease.	REMARKS.

N. B.—The attention of the Medical Practitioner is invited to Section 421 of the Bombay Municipal Act, 1888, quoted below.

Medical Practitioner.

Executive Health Officer, Bombay.

Section 421:—"Every Medical Practitioner who treats or becomes cognizant of the existence of any dangerous disease in any private or public dwelling other than a Public Hospital shall give information of the same with the least practicable delay to the Executive Health Officer. The said information shall be communicated in such form and with such details as the Executive Health Officer, with the consent of the Commissioner, may from time to time require."

422. The Commissioner may at any time, by day or by night, without notice, or after giving such notice of his intention as shall, in the circumstances, appear to him to be reasonable, inspect any place in which any dangerous disease is reputed or suspected to exist, and take such measures as he shall think fit to prevent the spread of the said disease beyond such place.

423. (1) If it shall appear to the Commissioner that the water in any well, tank or other place is likely, if used for drinking, to engender or cause the spread of any dangerous disease, he may, by public notice, prohibit the removal or use of the said water for the purpose of drinking.

(2) No person shall remove or use for the purpose of drinking any water in respect of which any such public notice has been issued.

424. (1) The Commissioner or any police officer empowered by him in this behalf may, on a certificate signed by the Executive Health Officer or by any duly qualified medical practitioner, direct or cause the removal of any person who is, in the opinion of such Executive Health Officer or other medical practitioner, without proper lodging or accommodation, or who is lodged in a building occupied by more than one family, and who is suffering from a dangerous disease, to any hospital or place at which patients suffering from the said disease are received for medical treatment.

(2) The person, if any, who has charge of a person in respect of whom an order is made under sub-section (1) shall obey such order.

[The certificate is usually in the following form :—

I do hereby certify that in my opinion (Full name and race of patient to whom the certificate relates)..is without proper lodging or accommodation, (lodged in a building occupied by more than one family) and, is suffering from a dangerous disease, namely,..............................

Place and Date { Signature : Health Officer.
Medical Practitioner.]

Order.

On the certificate of

dated..191 , I do hereby, pursuant to the provisions of Section 424 (1) of the City of Bombay Municipal Act, 1888, direct the removal of..

....

who is certified to be suffering from the disease of..............................to...being a hospital or place at which patients suffering from the disease of.................................. are received for medical treatment.

Place and Date. } Signature :

Municipal Commissioner.

Municipal Officer (empowered under § 68)

Police Officer.

425. (1) If the Commissioner is of opinion that the cleansing or disinfecting of a building, or of a part of a building, or of any article therein likely to retain infection, would tend to prevent or check the spread of any dangerous disease, he may, by written notice, require the owner or occupier of such building to cleanse or disinfect such building or part thereof or article therein and, if it shall appear to the Commissioner necessary, to vacate the said building for such time as shall be prescribed in the said notice.

(2) Provided that, if, in the opinion of the Commissioner, the owner or occupier is from poverty or other cause unable effectually to comply with such requisition, the Commissioner may cause the building or part of the building or article likely to retain infection to be cleansed or disinfected and defray the cost of so doing.

NOTE:—The person, if any, who has charge of the person in respect of whom the above order is made is bound under sub-section (2, of Section 424 to obey such order and failure to do so will render him liable under Section 471 to a maximum penalty of Rs. 100.

[The notice under Section 425 (1) is in the following form :—

To

The OWNER or OCCUPIER of building No. Street.

Whereas I am of opinion that the cleansing and disinfecting of the abovementioned building will tend to prevent or check the spread of a dangerous disease, namely, and it appears to me necessary that such building be temporarily vacated. Now in exercise of the power in this behalf conferred on me by Section 425 (1) of the City of Bombay Municipal Act, 1888, I do hereby require you to cleanse and disinfect the said building within days from the service hereof, and within the said period to vacate the said building and not to re-occupy the same until after the expiration of from the date on which the same shall be fully vacated as aforesaid.

Place and Date } Municipal Commissioner.

Municipal Officer.

Signature : Police Officer.]

426.(1) If the Commissioner is of opinion that the destruction of any hut or shed is necessary to prevent the spread of any dangerous disease, he may, after giving to the owner or occupier of such hut or shed such previous notice of his intention as may, in the circumstances of the case, appear to him reasonable, take measures for having such hut or shed and all the materials thereof destroyed.

(2) Compensation may be paid by the Commissioner, in any case which he thinks fit, to any person who sustains substantial loss by the destruction of any such hut or shed; but, except as so allowed by the Commissioner, no claim for compensation shall lie for any loss or damage caused by any exercise of the power conferred by this section.

NOTE.—Failure to comply with the requisitions of this Notice will render an owner or occupier so failing liable under Section 471 to a maximum penalty of Rs. 100.

427. (1) The Commissioner may provide a place, with all necessary apparatus and attendance, for the disinfection of clothing, bedding or other articles which have become infected, and in his discretion may have articles, brought to such place for disinfection, disinfected on payment of such fees as he shall from time to time fix, with the approval of the Standing Committee, in this behalf, or, in any case in which he thinks fit, free of charge.

(2) The Commissioner may, from time to time, by public notice appoint a place at which clothing, bedding or other articles which have been exposed to infection from any dangerous disease may be washed; and no person shall wash any such article at any place not so appointed without having previously disinfected the same.

(3) The Commissioner may direct the disinfection or destruction of bedding, clothing or other articles likely to retain infection.

(4) The Commissioner may, in his discretion, give compensation for any article destroyed under sub-section (3).

428. (1) No person who is suffering from a dangerous disease shall enter a public conveyance without previously notifying to the owner, driver or person in charge of such conveyance that he is so suffering.

(2) Notwithstanding anything contained in any Act relating to public conveyances for the time being in force, no owner or driver or person in charge of a public conveyance shall be bound to carry any person suffering as aforesaid in such conveyance unless payment or tender of sufficient compensation for the loss and expenses he must incur in disinfecting such conveyance is first of all made to him.

429. The Commissioner, with the sanction of the Corporation, may provide and maintain suitable conveyances for the free carriage of persons suffering from any dangerous disease; and when such conveyances have been provided, it shall not be lawful to convey any such person by any other public conveyance.

430. (1) No person who is suffering from a dangerous disease shall,—

(*a*) without proper precaution against spreading such disease, cause or suffer himself to be carried in a public conveyance ;

(*b*) cause or suffer himself to be carried in a public conveyance contrary to the provision of the last preceding section.

(2) No person shall go in company with, or take charge of, any person suffering as aforesaid, who causes or permits himself to be carried in a public conveyance in contravention of sub-section (1).

(3) No owner or driver or person in charge of a public conveyance shall knowingly carry or permit to be carried in such conveyance any person suffering as aforesaid, in contravention of the said sub-section.

431. The owner, driver or person in charge of a public conveyance in which any person suffering as aforesaid has been carried shall immediately provide for the disinfection of the same.

432. (1) No person shall, without previous disinfection of the same, give, lend, sell, transmit or otherwise dispose of any article which he knows or has reason to know has been exposed to infection from any dangerous disease.

(2) Nothing in this section shall be deemed to apply to a person who transmits, with proper precautions, any such article for the purpose of having the same disinfected.

433. (1) No person shall let a building or any part of a building, in which he knows or has reason to know that a person has been suffering from a dangerous disease, without first having such building or part thereof and every article therein likely to retain infection disinfected to the satisfaction of the Executive Health Officer or of some duly qualified medical practitioner, as testified by such officer's or medical practitioner's certificate.

(2) For the purpose of this section, the keeper of a hotel or inn shall be deemed to let part of his building to any person accommodated in such hotel or inn.

Special Sanitary Measures.

434. (1) In the event of the city being at any time visited or threatened with an outbreak of any dangerous disease, or in the event of any infectious disease breaking out or being likely to be introduced into the city amongst cattle including under this expression sheep and goats, the Commissioner, if he thinks the ordinary provisions of this Act or of any other law at the time in force are insufficient for the purpose, may, with the sanction of Government

(*a*) take such special measures, and

(*b*) by public notice prescribe such temporary regulations to be observed by the public or by any person or class of persons,

as he shall deem necessary to prevent the outbreak of such disease or the spread thereof.

(2) The Commissioner shall forthwith report to the Corporation any measures taken and any regulations prescribed by him under sub-section (1).

The Dangerous Infectious Diseases in India and the Tropics include :—

Intestinal.	Infectious, contagious or inoculable.	Conveyed by Insects.
Cholera. Diarrhœa. Dysentery. Sprue. Enteric Fever. (Typhoid). Typhus Fever. Beri Beri. Tuberculosis. Malta Fever.	Tuberculosis. Small-pox. Plague. Anthrax. Leprosy. Erysipelas. Dengue. Measles. Whooping Cough. Diphtheria. } Rare. Scarlet Fever. } Rare. Chicken-pox. Influenza. Puerperal Fever. Epidemic Pneumonia. Mumps. Tetanus. Actinomycosis. Glanders. Hydrophobia. Cerebro Spinal Meningitis.	Malaria. Relapsing Fever. { Filariasis and Elephantiasis. { *Kala Azar* and Oriental Sore. Yellow Fever. Sleeping Sickness.

As regards the "Intestinal" diseases, it may be stated that their prevention lies chiefly in sanitation, personal, domestic and public.

Infected food in some form, infected water or infected milk, infected carrier, human or animal, is the cause of these diseases.

Each of these diseases is conveyed by a special organism, in each case gaining access to the intestinal canal by the food, milk, or water, either directly or indirectly and possibly by infected latrines and the methods of ablution. Flies,ants and other insects, also rats amd mice may become carriers as well as infected human beings.

Koch has laid down certain conditions as to the microbial origin of communicable diseases, *viz.*:—

(1) The micro-organism must be found in the blood.

(2) The micro-organism must be isolated from the blood and cultivated in suitable media outside the animal body.

(3) A pure cultivation thus obtained produces the same disease when introduced into the body of a healthy animal.

(4) In the inoculated animal the same micro-organism must again be found.

The onset of an attack of most of the commonly recognized communicable diseases is characterised by fever. Hence the two expressions "fever" and "infectious disease" are commonly regarded as synonymous.

The first stage in the course of a fever is the "infection" or the time at which the germ of the disease enters the body. This period varies in different diseases. The manner in which the infective germ has gained access to the body varies considerably.

The period between the date of infection and the onset of the disease is called the *period of incubation,* and varies considerably in different diseases: in Small-pox from 12 to 15 days; in Enteric Fever few days to 3 weeks, &c. It is important to know as accurately as possible the incubation period of those affections against which we wish to adopt measures of prevention.

We next come to the onset of the disorders which in most cases is sudden and marked by a rise of temperature and other symptoms such as shiverings, convulsions, &c. In some, the onset is insidious, the patient being scarcely able to fix the day on which his illness commenced. The fever subsequently passes through two more stages, which may be called the *height* and the *decline* of the fever.

Further, there is a period of convalescence to follow, which may be short or long.

Cholera.

Cholera is an acute infectious disease characterised by profuse purging and vomitting of a colourless serous material, muscular cramps, suppression of urine, and collapse, and a high mortality, a special bacterium—Koch's Comma vibrio—being present in the intestines and discharges from the bowels. Cholera is usually considered a water-borne disease due to water having become infected with the Cholera organism by some person suffering from the disease. But the personal and direct infection are seriously to be considered.

Cholera in Bombay, Calcutta and British India compared.

In the following statement is compared the mortality from Cholera during 1901-1910 in the cities of Bombay and Calcutta and in British India; the death-rates per 1,000 of population are inserted :—

Year.	Bombay.		Calcutta.		British India.	
	No. of deaths from Cholera.	Death-rate per 1,000 of population.	No. of deaths from Cholera.	Death-rate per 1,000 of population.	No. of deaths from Cholera.	Death-rate per 1,000 of population.
1901	198	·25	1,720	2·02	271,210	1·21
1902	75	·09	2,716	3·20	224,136	0·99
1903	17	·02	1,990	2·34	312,854	1·38
1904	219	·28	2,056	2·42	192,835	0·85
1905	26	·03	2,323	2·74	441,786	1·96
1906	1,241	1·26	2,504	2·95	690,519	3·05
1907	439	·44	3,803	4·48	408,102	1·81
1908	95	·09	3,694	4·35	591,725	2·61
1909	727	·74	2,022	2·38	239,429	1·06
1910	107	·10	1,901	2·24	430,451	1·90
Total (1901—1910) ...	3,144		24,729		3,803,047	
Annual average ...	314	·35	2,472	2·91	380,304	1·67

Etiology of Cholera.

Cholera is now almost universally accepted as being due to a living contagium—Koch's Cholera bacillus which, growing in the intestines of the patient, causes death partly by the effect of the toxins produced by it and partly by the profuse purging which it sets up. The further etiology of the disease resolves itself into two factors: first, the means by which the microbe gains access to the body; second, the conditions which render the body susceptible to the microbe. Of the first of these we know much, of the second little.

Mode of Access:—It is certain that Cholera is not contagious in the ordinary sense of the word as Small-pox, Scarlet Fever, Measles. Nurses and those who attend to the sick are often affected in larger proportion than others; but this is readily explained by the fact that, unless constant care is exercised in regard to cleanliness of hands and utensils, they are much more exposed than are others to the known and recognised mode of infection, which is by the mouth. All evidence goes to show that the infection of Cholera to take effect must be swallowed.

Now, as in all zymotic diseases, the *materies morbi*—the *contagium vivum*—greatly increases within the body of the patient during the progress of his malady. During the disease a minute amount of infectious material grows into an amount capable of giving the infection to thousands and, in the case of Cholera, this infectious material finds its exit from the patient's body in the discharges caused by the disease.

The study of the etiology of Cholera, then, is to a large extent a study of the steps by which matter, that has left one patient, so gains access to some article of food as to be swallowed by some one else.

It is conceivable that, in the presence of a great abundance of the infection, it might be inhaled in the form of dust. Of this, however, there is no evidence.

It is with food and drink that it commonly gains access to the human body. Well-authenticated instances are related in which flies have appeared to carry the infection from Cholera dejecta to milk and various articles of diet; and Haffkine detected Cholera bacilli in specimens of sterilised milk, exposed in new vessels, to which flies were permitted free access during an attack of Cholera. The use of Cholera-infected water for washing cooking utensils and articles used in the preparation of food is another mode of local distribution. In the case of nurses and those who attend to the sick, or have charge of the dead, the Cholera poison may, as a result of want of strict cleanliness, be transferred to the mouth by the fingers, either directly or by means of food.

It has been universally accepted that the great, the persistent and the almost universal mode by which the Cholera germ gains access to the body is through the drinking water. This is now so well recognised that it is unnecessary to go again over the evidence by which this has been proved to demonstration. It is unnecessary here to refer to the classical examples of this mode of Cholera distribution.

This, however, is not the only mode by which the disease is spread in the larger cities of India. When a wholesome supply of drinking water is provided, the ignorance and carelessness of the people in preventing the pollution of the domestic supply, the storing of water in dirty vessels and the constant use of well and tank water to which infection may be conveyed must be an important factor.

The habits of the people, the customs with regard to the dead, the modes of preparing and consumption of food, the insanitary condition of their houses, the proximity of privies and bathing places to living rooms and the opportunity given to food and milk to become infected by personal contact and flies during an epidemic must provide an enormous source of danger.

There is a good deal of evidence to show that water does not act as a mere diluent and distributor of the Cholera poison, but that under certain conditions the Cholera bacilli grow and for a short time increase in virulence during their sojourn in this medium. The persistence of Cholera in a district is indicative of more than a single pollution of the water-supply, and generally points to a persistence of some insanitary conditions which favour repeated infection.

It is not always the case, however, that the infection is conveyed directly from man to man by means of water. Where we find sudden outbursts of the disease affecting large numbers of people drawing their water-supply from a common source, some direct and wholesale fouling of the supply is generally the cause of the mischief. But much more commonly, especially near its endemic home in India, Cholera does not occur in great outbursts ; small local epidemics arise, die down and then recur. The Cholera bacillus existing, as we must presume, in the foul soil is now and again washed into the wells, and so sets up disease in those that draw their water from them. The key, then, to this side of the etiology of Cholera is to be found in the habits of the people and the degree of care or want of care they exercise in the protection of their water-supplies.

Individual Susceptibility.—The etiology of Cholera is not, however, completely explained by the statement that it depends on the ingestion of Cholera infected water; another condition is also necessary, namely, the susceptibility of the individual. Considerable differences exist in the habits of the various members of every community : thus, it often happens that even where the habits of the majority are foul, a few are protected from receiving the infection by the greater cleanliness and propriety of their lives. Yet many fail to sicken, although they are known to have swallowed the very infective matter which at the same time is producing Cholera in others. We have proof of this in every widespread water epidemic ; the number of those who swallow the poison must in these cases vastly exceed the number of those who are attacked by the disease. Macnamara gives an instance in which a vessel of drinking water was accidentally polluted with fresh Cholera excreta, and after being exposed to the sun all day the water was partaken of by nineteen persons ; of these five only subsequently suffered from Cholera. It seems clear that the inhabitants of the areas in which Cholera is frequently present, notwithstanding habits which expose them continually to chances of infection, are much less frequently attacked than new arrivals in the districts, much less, for instance, than Europeans, although when attacked, they succumb more readily.

Dissemination by human intercourse.—There can no longer be any doubt that Cholera is disseminated by human intercourse. The march of Cholera coincides with the march of man, and it is carried from place to place either by infected man or by Cholera-tainted clothing. The part played by pilgrimages, *e.g.*, the pilgrimage to Mecca, is well known, and severe outbreaks and wide dispersion have often followed on such movements of large bodies of men. There seems no practical limit to the distance to which it would be possible to transmit the infection in a bundle of imperfectly dried rags soiled by Cholera excreta; man, however, can but carry the disease so far as he is able to travel between receiving the infection and being laid low. What we find, then, on comparing the march of the earlier epidemics of Cholera with those that have occurred in more recent years, is that whereas when travel was slow the disease swept steadily forwards, occupying the land as it advanced in later times it has bounded forward with long strides, occupying outposts far ahead of infected areas, by means of railway and steam-boat communication, and then, from these outlying foci of infection, has spread in both directions coalescing perhaps at a much later date with the main body of the epidemic which has slowly advanced across the country from the earlier centres.

Certain as it is, however, that man is the porter by whom Cholera is introduced to any place, it must not be forgotten that its development in that place depends on insanitary circumstances, the chief condition necessary being the liability of the drinking water to be contaminated by infected excreta. There are probably other but more obscure conditions still unknown to us.

Even amidst the conditions of soil and climate most favourable or most inimical to Cholera, its prevalence largely depends upon the habits of the people: however largely present its contagium may be, it is harmless unless swallowed. Thus, among all the influences making for Cholera, the most important are those habits of carelessness as to the cleanliness of food and drink, which make it easy for either the one or the other to be tainted with fæcal material.

BACTERIOLOGY OF CHOLERA.

The bacteriology of Cholera has provided the subject for an enormous amount of work. Koch, who discovered the Comma bacillus vibrio, visited India in 1883 and was followed by Klein and Gibbes in 1885 and later by Haffkine.

It is unnecessary to repeat the investigations of eminent observers and the enormous amount of work done in the bacteriology of Cholera which have brought us to our present knowledge. It is accepted, rightly or wrongly, that the vibrio called the Comma vibrio of Koch is associated with Cholera; that the organism exists in the stools of Cholera patients, that it can be isolated and can exist in water; that the stools of Cholera patients, either directly from the body or from the clothes and discharges, can infect water and food and milk and thereby convey the disease.

There is an enormous field for further scientific research in the bacteriology and epidemiology of Cholera.

With the improved technique of the laboratory and the opportunities now given for research work in tropical diseases, the investigations into the bacteriology and epidemiology of Cholera should be considered of the first importance.

A great deal of work has been done with the Cholera vibrio and the laboratory methods and technique are delicate and uncertain.

INVESTIGATION INTO POSSIBLE CAUSES OF OUT-BREAK.

On the appearance of Cholera in any part of a city, the methods adopted for the investigation of its causes are as follows:—

The name, age, sex, occupation, place of work and length of residence at present address are inquired into; and the information sent daily to the Head Office by the Health Officer of districts.

The food-supply, milk-supply and water-supply and the possibility of infection from a former case either in the city or outside form the subject of inquiry.

If a case existed in the premises the water is examined and if a well or tank exists it is treated with permanganate of potash as a precaution. Each case is followed up, and the connection with a previous case ascertained, if possible, and all precautions are taken to prevent the spread of the disease.

Spot maps should be made giving each attack and death.

The Bacteriology of Cholera and its relation to the spread of the disease from the point of view of the Health Officer.

The following notes may be of interest in the very difficult question of the relation of the Cholera vibrio of Koch to the spread of Cholera :—

Experiments were carried out during the recent outbreak of Cholera in Bombay, June—August, 1912. From these investigations, the following conclusions were drawn :—

(1) That the Comma vibrio is present in the excreta of persons dying or suffering from Cholera.

(2) That the vibrio persists until sometime after the patient is convalescent but not indefinitely.

(3) That in times of a Cholera epidemic the vibrio is found in waters, wells, tanks, vessels, etc., but that it does not retain its morphological and cultural characteristics or its virulence for any length of time.

(4) That an out-break of Cholera depends on :—

1. The strength and quantity of the dose of the virus received.
2. The condition of the infected material which gains access to the intestine.

3. The physical condition of the patient and his power of resistance.
4. Certain climatic conditions.
5. Sanitary surroundings of the people ; water, food, drainage and refuse disposal and the habits of the people.

(5) The fact that when the vibrio leaves the infected person it loses its virulence in direct ratio to the time and conditions to which it is subjected.

From investigations by daily visits of inspection to the infected houses, streets, wells and tanks in B Ward and from bacteriological examination carried on during a severe outbreak of Cholera in Bombay, there is sufficient evidence to assume that the water had been polluted directly or indirectly from Cholera cases.

In order to ascertain the probable cause of the outbreak, in addition to the epidemiological investigations, many samples of water from wells, tanks, open vessels and tap water were examined as well as *post mortem* examination made of intestines and the fæces of patients dying of the disease.

During January to August, 114 samples of Municipal waters were examined in the Laboratory ; 257 samples of other waters, 16 of milk and food stuffs and 18 of excreta of Cholera patients. These examinations were conducted until September and the fæces of 62 patients examined.

During visits of inspection attention was drawn to the following :—

(1) To provide water for the people large earthen vessels were placed in the streets ; they were filled with water by *bhistis* from tanks, stand pipes and wells.

(2) During certain hours of the day and night the Municipal water-supply was shut off owing to the scarcity of supply and that *bhistis* were providing it to the houses.

(3) Stand-pipes in the City are used as bathing places and for washing clothes and utensils.

(4) *Bhistis* filled their *mashaks* at these standpipes immediately before, after, or, if possible, at the time people were washing their bodies and clothes.

(5) The large reservior at Pydhoni adjoining the Police Station was a favourite place for this purpose, and although there is a notice pointing out that these stand-pipes were not meant for washing bodies and clothes and although it adjoins the Police Station, dozens of people are to be seen daily fighting for water and washing their clothes. This was pointed out to the Police who temporarily stopped it.

(6) *Bhistis* when they cannot get a supply of water from stand pipes get the water from tanks and wells at mosques and other places, and carry the water to private houses, where it is stored in various kinds of tubs, earthenware pots, etc.

The possibility of conveying infection through water is apparent.

The *bhistis' mashaks* during the outbreak were washed with lime and permanganate solutions.

Now supposing that water is contaminated with material from an infected house, person or clothes, it is not unreasonable to assume the probability of the disease being spread in this way.

Samples from open vessels in the streets and houses, tanks and wells in the mosques were examined. It was found, from the result of the analysis of the many samples that were sent, that the majority of the waters were contaminated with fæcal matter, and in some instances an organism having cultural characteristics of the Cholera vibrio was detected.

Although a vibrio was present in many samples, it was not until a sample from a well in a mosque in Kazi Syed Street was examined that what appeared to be the real Cholera vibrio was found. The well is inside the mosque and adjoining it, a tank and a place where dead bodies are washed in the mosque. Three deaths from Cholera occurred here and many dead bodies were washed in a place close to the well and tank. Outside the mosques are galvanised vessels filled with water for the use of the passers by.

As has been pointed out, to obtain a pure culture of the Cholera vibrio in a well or tank water is not easy, especially in India where many other vibrios exist.

Water is much fouled with organic matter, and the presence of other bacteria to a certain extent smothers the Cholera vibrio.

The bacteriological tests which were used in the Municipal Laboratory are as follows :—

(1) 90 c. c. of the water to be examined was put in a narrow mouthed flask with 10 c. c. of an alkaline concentrated peptone solution and incubated for 24 hours.

(2) This was then examined microscopically and after staining with carbol fuchine, if vibrios were present—

(3) A loop full of the peptone solution was inoculated into a sterile broth culture medium.

(4) A sub-culture was immediately made in agar slant tube.

(5) Further dilutions were made in another broth tube.

(6) A further sub-culture was made into slant agar tubes and incubated for 24 hours, and then examined microscopically as in (2).

(7) Colonies from the agar were then further sub-cultured on agar and subjected to other tests.

Another method—48 hours' peptone cultures were plated out on agar petri dishes and incubated for 24 hours and the colonies were examined.

Pure cultures were then examined as follows :—

Microscopically, stained as before, motility, Cholera red re-action, Nitroso-indol, Ehrlich Rosindol reaction—staining for flagella—agglutination and Pfeiffer's test.

All the tests mentioned above, with the exception of the Pfeiffer test were applied to the vibrio isolated from this well water in the Municipal Laboratory and found to be positive.

Now, if there is any organism that varies in its cultural, morphological and pathogenic properties, it is the Cholera vibrio, and from the latest investigations, with the most modern bacteriological technique, it is stated that "the power of anti-Cholera serum to agglutinate the vibrio is very variable."

That because either agglutination or Pfeiffer's test is negative, it does not follow that in the presence of an epidemic a vibrio, not responding to these tests, should not be considered to be a Cholera vibrio for all practical purposes.

Under the circumstances, from these investigations, it is proved that this well water was infected with material from a Cholera patient, and that it was possible many other wells and tanks and water-vessels were infected in a similar way.

This is as far as any observers have ever got in the bacteriology of the disease, and until we know more we must assume that Cholera is spread in this way.

For the practical sanitarian this is enough to work upon. Given an outbreak of Cholera, whether imported or indigenous, any sample of water, from which a pure culture of the comma vibrio is obtained, is sufficient evidence for active preventive measures.

The Cholera vibrio, after it leaves the human body, undergoes such rapid modifications in water, milk, food, soil, or even on the soiled clothes and discharge of the suffering person as to render it almost unrecognisable. The organism, fortunately for the human race, is very faintly resistant to external influences ; and it is for this reason, that when an outbreak occurs, prompt sanitary measures can control it.

How far, and how long, a Cholera vibrio can retain its virulence externally to the human body and how far the other organisms in water affect it are still subjects for further investigation. How the attenuated organism, found in water, can again regain its virulence when entering the body of its former host is what we want to know. Until then the practical sanitarian must consider all water containing a Comma vibrio, in the presence of a Cholera outbreak, a danger which by all the means in his power should be attacked.

Without entering into the bacteriology of the innumerable Cholera-like vibrios found in water and fæces, the presence of a Comma vibrio in water during a Cholera epidemic is evidence of probable contamination from a case of Cholera, though, as already pointed out, it is held that infected water is always the cause of the spread of Cholera, and that personal contact has little to do with the spread of the disease.

Personal element in the spread of Cholera.

It is impossible to analyse the evidence collected during the outbreak in Bombay without coming to the conclusion that the personal element has a great deal to do with the spread of Cholera in India. Without labouring too much on the habits and customs of the people, there is no doubt that the spread of Cholera is greatly due to direct infection from person to person by means of the discharges, contaminated hands, food, vessels, milk and water and flies.

The filthy privy baskets, overflowing into open drains and thus soaking into sub-soil or storm-water drains, the position of the water sewer pipes and the common washing places are a constant danger at any time, but in the presence of Cholera, must contribute to a large extent to the circumstances favouring the spread of the disease.

For example, on visiting a person suffering from the disease, he or she will be surrounded with relatives and friends handling the patient. Many will be found occupying the same room, sleeping on the floor ; they all use the same privy and washing place, eat from the same vessels ; the water is stored in wooden, iron, earthenware or other vessels, in the living room, cook-room or *nahani*, for days together. The friends and relatives will wash the dead body and take it to the burial ground or burning *ghat* and afterwards wash in the nearest tank or bathing place—without any disinfectant precautions.

Any one familiar with the homes of the poor can easily understand how Cholera is thus spread.

The following are some instances :—

A man, Hindu, living in a well-built *chawl*, the servants' quarters of a large bungalow on Malabar Hill, occupied a room by himself; he had his meals with a man and woman in an adjoining room. No case of Cholera had occurred in the neighbourhood. He visited the *Bazar* one day, came home and took ill with vomitting and Diarrhœa; he was nursed, fed and attended to by a woman in the adjoining room. This man was removed to hospital that evening in a collapsed condition and died two hours afterwards. Next day, the woman, who had attended him, took ill with Diarrhœa and vomitting, and after some difficulty was persuaded to go to hospital, and she recovered.

House No. 2, C. Street, three deaths occurred on the ground and first floors occupied by the same family—well-to-do Mahomedans. The first case occurred on the 12th, the second on the 13th, the third on the 14th. The house is situated back to back to another separated by a narrow sweeper's passage or gully from a house in B. Street, where seven deaths occurred, four on the 11th.

From house No. 25, friends and relatives visited house No. 2, where the three cases were suffering; three deaths occurred at house No. 25, on the 14th, 19th and 19th.

From house No. 25, a suffering case was taken to house No. 1-3, M. Street, and died there.

At house No. 25, a lady came to visit and remained there some days, took ill, was taken to No. 207. A. O. Street in C. Ward, and died there.

A number of similar instances could be given.

This is nothing new in the epidemiology of Cholera, as witness the Fairs held in India.

Large crowds of people assemble, Cholera breaks out and is only checked when the fair is over, or the proper sanitary precautions have been taken to prevent the pollution of the water-supply, and other sanitary precautions observed with regard to food and cleanliness of the camps and destruction of all infected material.

Many persons leaving the Fairs perfectly well are attacked or die on their way home or recover and return to their homes convalescent, thus becoming a focus to spread the disease elsewhere.

Facilities of transit are so many that the disease may be carried hundreds of miles in a few hours.

Bombay City is a very small unit of the Indian Empire or even of the Bombay Presidency, but it is the haven of refuge for the destitute as well as the prosperous in times of famine and sickness in the neighbouring districts and thus pays the penalty of its position.

The difficulties of obtaining information from the friends and relatives of infected people and the passive resistance to any sanitary measures make it extremely difficult to trace cases of infectious disease or to adopt measures for their control.

Indifference and carelessness on the part of the poor people to accept any advice adds to the difficulties of control, while the ignorance of any measures of personal hygiene and the rooted objection to any innovation in their domestic arrangements form obstacles difficult to overcome.

The following routine method was used in the examination of the samples for Cholera in the Municipal Laboratory :—

For samples of water—

I.—90 c. c. of the water was transferred to a narrow-mouthed sterile flask containing 10 c. c. of concentrated peptone solution. This was placed in the incubator at 37° C. for 24 hours.

II.—Smears were then made and examined microscopically after staining with 1-10 Carbo-fuchism. If the smears showed any Cholera-like organisms, then one of the following methods was followed in isolating the pure culture of Cholera vibrio.

III.—*Method A.*—

(*a*) One loopful was removed from flask (1) containing 24 hours' culture on peptone and put in a broth tube. This was labelled (2).

(*b*) A sub-culture was immediately made on slant agar (2*a*).

(*c*) Further dilution was now made by taking a loopful from (2) and putting it in a broth tube labelled (3).

(*d*) An immediate sub-culture was made from (3) into slant agar (3*a*). The tubes were then incubated at 37° C. for 24 hours.

(*e*) At the end of 24 hours several suspicious-looking colonies were selected from (2*a*) and (3*a*) and examined in the usual way microscopically.

(*f*) Such isolated colonies were again sub-cultured on agar for 24 hours, after which they were subjected to other tests for Cholera vibrio (*q. v.*)

Method B. for isolation of Cholera vibrio.—

In this method 48 hours' old peptone cultures were plated on petri dishes and incubated at 37° C. for 24 hours. Several colonies were picked up from these and examined in the usual way.

IV.—*The pure sub-culture obtained by method A were then examined as follows vibrio :*—

(1) Morphology.

(2) Motility.

(3) Cholera red reaction—

(*a*) Nitroso-indol Reaction with sulphuric acid (this was tried in 24 and 48 hours).

(*b*) Ehrlich's Rosindol reaction with Paradi-methylami dobeyal dehyde. This was also tried in 24 and 48 hours.

V.—*Staining for Flagella*—

Stephen's stain was used on a fresh sub-culture (under 24 hours).

VI.—*Agglutination test*—

This was tried with serum usually obtained from the Bombay Bacteriological Laboratory, Parel.

VII.—*Method for examining samples of fæces from Cholera patients.*

These were either passed through peptone water and isolated on slant agar or diluted through broth and immediately inoculated on slant agar. The rest of the method was the same as in the case of water.

The method of examining samples other than those of waters or of fæces does not differ materially from method No. 1 (*q. v.*) excepting that smaller amount of peptone water is used up.

Pfeiffer's Reaction and Growth on Sugar Media.

In this investigation the main difficulty was felt in the isolation of a pure culture of Cholera-like bacilli from all the other organisms present in the water. This is the main difficulty usually experienced by most bacteriologists. After trying various methods we were fortunate enough to isolate a pure culture by method A., as described above. This method is simple, quick, and there is no risk of external contamination.

Method B., although used by many bacteriologists, was not found so satisfactory. Besides in method B. there are many chances of external contamination during the manipulations.

The isolated organisms were typically comma-shaped with marked curve, actively motile, with one terminal flagellum, gave the "Cholera red" reaction within 24 and 48 hours, showed complete or partial agglutination and gave acid but no gas in sugar media.

The agglutination test was not positive in all cases, and this may have been perhaps due to the serum not being homologous to the organisms isolated by us.

Out of the 370 samples of waters examined for Cholera vibrio, it was detected only in two samples of well waters—(1) well at No. 34-36, Mount Road and (2) well at Bohra's Mosque, No. 10, Cazi Sayyad Street—with positive results, both microscopically and culturally. Besides comma-like bacilli were seen microscopically in 16 samples with negative results for cultural tests as follows—

5 well waters, 6 tap waters, 3 tank waters, 1 water from earthen pot, and one not classed.

CHOLERA CARRIERS.

The following is an extract from a report prepared by Dr. Crendiropoulo, Director of the Bacteriological Laboratory of Chatby, Alexandria, published by the Conseil Sanitaire Maritime and Quarantenaire of Egypt, upon an examination of the stools of travellers coming from countries infected with Cholera. The investigation was started owing to the following incident:—On August 16th, 1911, a Belgian steamer arrived at Alexandria from Smyrna, where Cholera was present. On the fifth day of the period of quarantine, a little girl, 5 years of age, died with symptoms suggestive of Cholera. At the necropsy the characteristic lesions of this disease were not found, but bacteriological examination revealed the presence of abundant vibrios, and cultures made from them were powerfully agglutinated by Cholera serum. Examination of the stools of all the other persons on board the steamer showed that one woman, a servant in the family to which the dead child belonged, was a carrier of an agglutinating vibrio. Other incidents of similar nature occurring within a few days showed the danger these carriers represented for Egypt, and the Conseil Quarantenaire, on the proposition of Dr. Armand Ruffer, authorized the quarantine authorities to carry out bacteriological examinations as part of their visit in all cases where they considered it necessary. In consequence, between the dates of August 17th, 1911, and January 31st, 1912, the passengers and crews of 297 vessels were submitted to an examination of the stools as part of the routine examination for quarantine. The total number of stools examined was 34,461, and of these 14,553 were obtained from the crews and 19,908 from passengers, mostly from those of the poor class, although in some instances every person on the boat was examined. Vibrios were found in 63 cases, and of these 23 possessed agglutinating properties with Cholera serum, while 40 did not. Of the 23 agglutinating vibrios only 2 came from members of the crews, while of the 40 non-agglutinating, 12 were found in members of the crews. The percentage of agglutinating vibrios was therefore, about 0·07, but it was found that in the 44 days from August 17th to September 30th, during which the epidemic was at its height, there were ten times more carriers than during the remainder of the period. In general, Dr. Crendiropoulo finds that agglutinating vibrios are only found in travellers from infected countries and only when an epidemic is at its height. During the decline of an epidemic carriers become extremely rare. It is interesting to note that the greater number of carriers were found in passengers and that the crews were but rarely affected. All the carriers were kept in quarantine until the disappearance of their vibrios which took place in most cases within five days, though in one case they persisted for eight days. Dr. Crendiropoulo is careful to point out, however, that the limit of five to eight days must not be taken as the ordinary time of persistence of the vibrios, since they had probably been present for some time before they were discovered. In regard to the non-agglutinating vibrios, their frequency is found to be in inverse proportion to that of the agglutinating. They become more abundant as the carriers of true Cholera vibrios become fewer, but both of them cease altogether when the epidemic comes to an end. Dr. Crendiropoulo gives an interesting and exhaustive account of the bacteriological characters of the vibrios obtained, including their virulence for the pigeon, liquefaction of gelatin, coagulation of milk, the production of haemolysis and the indol reaction ; and he concludes that none of them can be relied upon as a criterion for the diagnosis of the Cholera vibrios. Even the fixation of complement and the agglutination reactions are not free from doubt. As a result of his observations he suggests that every carrier of vibrios, whether agglutinating or not, who comes from a place where the disease is epidemic, should be held as a suspect.

PRECAUTIONS TO BE TAKEN BEFORE AND AFTER A VILLAGE HAS BECOME INFECTED.

Fairs, feasts and festivals are very common in India and pilgrims from all parts of the Empire flock to them at certain times. Holy cities and villages thus become suddenly overcrowded with people who have to live under the most in sanitary conditions, and it frequently happens that Cholera breaks out and is rapidly spread not only amongst the pilgrims but wherever they go and on returning to their homes they convey the disease. Railway communication fosters the spread of the disease to distant places which may become a focus and thus Cholera may be rapidly spread over a very large area. Previous to the arrival of the pilgrims, huts should be erected properly laid out in blocks with suitable sanitary conveniences so as to render supervision easy. The majority of the pilgrims are entirely ignorant and absolutely callous as regards pollution of streams, rivers and tanks. Thousands may be seen bathing and washing their clothes in the water they have to use for drinking. The river banks and the river itself are polluted with human excretions.

When a village or place visited by pilgrims has become infected with Cholera, special precautions should be taken to protect the water supply and bathing places ; a strict and efficient system of conservancy should be adopted and guards placed in charge of the water supply and the conservancy system. The authorities in the adjoining village and town and places through which returning pilgrims pass should be daily informed of the progress of the epidemic. The latrines should be built of temporary structures well away from the huts or dwelling places and should be inspected twice daily and the receptacles properly disinfected; the contents treated with izal 5 per cent. or chloride of lime and burnt or buried two feet deep well away from the camp to the leeward side. A proper system of disposal of the excreta is most important.

All bathing places should be kept separate from the river or drinking supply, and disinfected twice daily. If a river supplies the drinking water, no bathing should be allowed above the source of supply and proper channels should be cut to get rid of polluted water in the bed of the river.

Overcrowding in the huts and common lodging houses should be prevented and strict medical supervision enforced; every case notified and isolated and a temporary incinerator and disinfector erected for the burning of refuse and disinfection of clothes. All vehicles and railway carriages should be regularly disinfected and the railway authorities instructed to notify cases or deaths occurring in the carriages or coming to their knowledge. Railway stations to which pilgrims return from Cholera infected places should be inspected and all cases removed to hospital, and the names and addresses of the relatives or persons taken down so that they could be visited at their homes.

The *measures for the prevention of the spread* of the disease are:—to early notify the disease, isolate the patient, disinfect or burn the stools and infected clothing, disinfect all utensils, boil milk and water, provide a pure supply of water and milk and food; to protect the food from flies, disinfect houses and latrines, trace the cause of the disease, isolate convalescent cases, protect the water and milk supplies, immediately remove all refuse and to issue printed instructions.

Fresh chlorinated lime or powder in the proportion of two tablespoonsful to a pint of Cholera discharge is effective in 25 minutes. Strong izal 5 per cent. and carbolic acid 1-10 can be used by completely covering the discharges. For lime-washing rooms, ½ lb. of chlorinated lime (bleaching powder) should be added to 7 gallons of lime wash.

Instructions for the Prevention of Cholera.

Origin of Cholera.—Cholera results from swallowing, with food or drink, minute organisms or germs, which, developing in the intestine, excrete a poison and give rise to the characteristic symptoms of the disease.

Spread of Cholera.—The germ of Cholera does not naturally exist in articles of food or in water, but gains access to them through the agency of infected persons. These germs are found in large numbers in the stools of the Cholera-stricken, and it is thus easy to understand how infection clings around a person sick with Cholera. Beds, bedding and clothing become soiled with the evacuations. The floor around the bed, or on which a sick person lies, the patient's own hands, and also the hands, feet and clothes of the attendant are all liable to infection from the same source. The patient infects everything he handles and vessels used by him may convey disease to other members of the family. The attendant who cooks food or draws water may carry infection to these articles.

Again, if evacuations of a patient are thrown carelessly outside the house, flies settle on the filth and returning to the house carry Cholera germs to food and water which may be exposed.

There are thus many ways in which infection is spread in a household, and by which Cholera attacks one after another of a family.

But Cholera also attacks several families at once in a village, and this is because the water in the well, tank or stream has become infected and many persons drink the water. The evacuations of the Cholera-stricken, if thrown on to the ground, may get washed during the rainy season into any of these sources of water ; dirty pots, soiled clothing washed in the tank or stream, or near a well, will foul the water, or dirty infected water pots used for drawing water will spread infection. In one or other of these ways Cholera germs get into the water used by the village ; they multiply and give rise to a general outbreak.

Fortunately the Cholera germ is a delicate organism, easily destroyed by heat and disinfectants. Disinfectants may not always be obtainable, but fire is always ready to hand. On the first appearance of Cholera in the village, steps should be taken which will destroy germs and thus prevent its spread.

Cleanliness in the house and the removal of refuse and filth from the vicinity will help to keep away flies, and thus lessen the risk of the introduction of infection through their agency. All water of the house should be boiled for 5 minutes and allowed to cool before use. This will kill any germs in the water. Only freshly cooked food should be eaten. This also will lessen the risk of infection from flies, which readily settle on food left exposed.

Sweetmeats or other food exposed in shops, swarming with flies, should not be eaten.

Raw vegetables, or unripe or over-ripe fruits, should be avoided as they are apt to cause Diarrhœa, since Diarrhœa predisposes to Cholera.

Any symptoms of Diarrhœa should receive prompt treatment.

The above are measures which can be adopted in every household. In addition, there is an important preventive measure affecting a whole community in the disinfection of all sources of water by permanganate of potassium. This is a crystalline powder which, dissolved in water, colours it pink, the colour lasting for several hours. It is quite harmless to those using the water, but by destroying germs it prevents the spread of Cholera. The permanganate should be used according to the directions which follow. Bearing in mind the dangers of contaminated water, and the risk of infection being carried by flies, special efforts should be made to keep the village site clean ; people should be urged to go outside the village site for natural purposes, and away from tanks or streams. Warning should also be issued against washing soiled clothes near wells, or in tanks or streams from which household water is drawn.

Precautions to be adopted in an infected household.

On the first appearance of Cholera, the *Patel* of the village should send to the *taluka* head-quarters for Cholera mixture, permanganate of potassium and phenyle.

The sick person should, as far as possible, be kept apart from the rest of the family.

All articles, such as bedding, clothing, drinking vessels and dishes for food, which are used by the patient, should remain in the sickroom and be kept for his use only.

The evacuations should be received in an earthenware vessel, *gumla* or chatty, in which some phenyle is always to be kept, and should be buried, not thrown on the ground.

The floor around the sick person and under the bed should be washed once a day with izal or phenyle solution, 1-20.

A solution of phenyle should always be kept ready with which attendants should carefully wash their hands after each act of tending the sick. Cholera mixture for the patient and phenyle for making a disinfecting solution should be asked from the *Patel* of the village.

The disinfecting solution is made by taking one part of the strong phenyle and adding to it 50 parts of water, when a thick milky liquid is obtained.

If phenyle or other disinfectant is not obtainable, the attendant should use all the more care in burying all evacuations and in washing the hands frequently with clean water, and wherever the floor around the sick person gets soiled, he should sprinkle hot wood ashes.

Precautions to be adopted after the death or recovery of a patient.—Every article of bedding and clothing, the tapes or coir of the charpoy, the feeding and drinking vessels should be boiled for half an hour before allowing them to be washed, so as to destroy all germs. The floor and walls of the sick room should be washed down with phenyle solution before being smeared with cowdung or limewashed.

Cremation or burial of those dying of Cholera should not be carried out near any source of water. Cremation should be most thorough, and burial at least 6 feet under ground.

Summary.—Cholera results from swallowing living organisms with food or drink. These organisms are easily killed by heat, and therefore freshly cooked hot food and boiled water can be safely used.

When Cholera is prevalent in an infected household, isolation of the sick, strict cleanliness and the free use of phenyle by the attendants and disinfection by steam or burning of all infected articles will best prevent Cholera attacking other members of a family.

In an infected village, in addition to these precautions, disinfection of wells by potassium permanganate will check the outbreak.

Directions for the use of Potassium Permanganate in disinfecting Wells, etc.

Put two ounces of permanganate in the solid state into a *dol* or bucket that has been filled with water from the well about to be treated. Stir it up and pour the red solution thus produced into the well, leaving the portion of permanganate that is not yet dissolved at the bottom of the *dol.* Lower the *dol* into the well, fill it with water, draw it up, pour back the water as before. Repeat the process till all the permanganate has been dissolved. After half an hour draw up some of the water and examine it. If a red colour is still present, enough has been added. If the red colour has disappeared, then more permanganate should be added to the water in the well. In all cases enough permanganate should be added to produce a faint red colour lasting 24 hours.

If the water in the well is bad, more permanganate will be necessary. In such a case it will be found that the strong red colour at first produced slowly changes to brown and then fades away. This is because permanganate and dirt destroy one another. Therefore more permanganate must be added in order to produce a lasting colour. If the water in the well is clean, a smaller quantity of permanganate will be found to be sufficient; from one to eight ounces of solid permanganate will be found to be sufficient for ordinary wells. If possible, the permanganate should be added at night in order to leave the wells undisturbed as long as possible. The water will be fit to drink on the following morning. If at this time the water has a red colour, it will have a slightly unpleasant taste, but it is perfectly harmless. If the inhabitants do not like the taste, they should be instructed to pump out the water until the colour vanishes.

Disinfecting Staff—Instructions against Cholera in Towns.

In Bombay the Inspectors must ascertain in every case whether all the personal clothing worn by the patient and all the bedding and any article of attire which may have been soiled by vomitted matter or fæcal discharge has been collected and dealt with by the District Registrar or his staff on his preliminary visit. The District Registrar has instructions to immerse all such articles in *perchloride solution* pending the arrival of the Disinfecting Staff. The Disinfecting Sub-Inspector must remove all infected clothing for steam sterilization. It is of the utmost importance that no infected article be overlooked, and it is considered a very serious neglect of duty if any instance of such is detected.

2. *All water taps* must be carefully washed with freshly prepared permanganate solution and the water allowed to flow freely for a few minutes afterwards.

3. Careful search must be made to see if *any well* exists in the premises, if so it must be treated with permanganate solution. A solution of the crystals must be made first and then added to the well water till the latter remains pinked for about half hour.

4. *Every privy seat* should be carefully scrubbed with a brush, using plenty of water with some izal solution in it. The walls and floor of the privy must also be well washed with the same solution. If necessary *pesterine may be applied subsequently.*

5. As far as possible all drinking utensils, plates, knives, &c., and all "chatties" should be well washed in a *solution of izal* and subsequently washed in clean tap water.

6. *The rooms* should be carefully swept (all furniture being removed) and then disinfected with perchloride solution

or izal. The furniture should be well rubbed with a cloth soaked in izal solution and any table or article of furniture that will permit washing should be so treated.

7. The members of the family should be informed that it is essential to observe the greatest strictness in regard to cleanliness of their hands and utensils when taking food.

8. The privy floor and receptacle and also the trap door, if present, and the walls should be most carefully cleansed under the personal supervision of the Sub-Inspector. After thorough cleansing the whole trap should be treated with pesterine. The object of so doing is to lessen the risk of conveyance of the disease by the agency of flies, and it is most important that the work be carried out in a conscientious and thorough manner.

On enquiry into the cause of an outbreak of Cholera and Enteric, and the spread of these diseases, many points will have to be considered and many things enquired into in the cities and villages in India—which are opposed to all the elementary teachings of sanitation.

The milk supply may be from the buffalo or cow direct, brought to the house door or kept in the compound. If the milking process is supervised by a reliable servant, the milk may be as pure as the animals can give it, but the *gowli* or milkman, his vessels, his family and domestic surroundings require the strictest attention, if pure milk is expected. The milk may be from a dairy, or collection of milch cattle, and the conditions under which they are kept and milked require all the supervision the authorities can provide. The milk may be from a small shop to which it has been brought and its composition and quality is likely to suffer during transit, or before distribution ; this can be ascertained only by analysis ; the water with which it is adulterated may be contaminated ; the milk may come from a so-called up-to-date dairy in a large city, sent out in sealed cans or bottles ; a periodic examination of even this supply and the dairy itself is necessary. The milk may come from a distance, by train or carried on the head of a cooly in open brass vessels, or by a bullock cart, and may have to pass through many vicissitudes before arriving at its destination. All this points to a pollution of the milk before being consumed, and boiling is always advisable.

DIARRHŒA, DYSENTERY AND SPRUE.

Diarrhœa, Dysentery and Sprue are intestinal diseases due to a microbe, organism (bacterium) or parasite, gaining access to the intestines through the medium of food, water, milk, dust, &c., and a human carrier.

These diseases may occur in epidemics, especially Diarrhœa in children (?) during summer and autumn months, and point to infection through food, milk or water, dust, &c.

The infective material may be carried by flies from infected latrines or dirty utensils.

The same precautions should be taken as in Cholera : good sanitary arrangements and immediate disposal of refuse and disinfection of the stool ; water and milk should be boiled, and the food and vegetables should be fresh and well cooked.

Diarrhœa.—Klein attributes Diarrhœa to the Bacillus enteritidis sporogenes, which is found in dust and air, and fæces, milk and food.

The food and milk should be protected and the latrines disinfected, the larvæ and eggs of flies destroyed and clean cooking utensils insisted on.

Climate and change of food have a great effect on the intestinal canal of Europeans in India, and many people suffer from Diarrhœa as soon as they get to a hill station, but recover when acclimatised.

Infantile Diarrhœa is due to want of cleanliness and impure feeding, the food and milk becoming contaminated.

Epidemic Diarrhœa is almost always associated with increased temperature of the air and autumn changes, and the mortality is for the most part among infants and very young children; still there are records from time to time of epidemic Diarrhœa at various seasons (even in mid-winter) when those who died were not even chiefly little children. The length of the latent period there is no means of computing, but it is certainly short. The attack begins with pain in the epigastric region, or abdominal griping, some rise of temperature, vomitting and Diarrhœa. The stools show that there is intestinal catarrh, and are sometimes bloody. There is commonly thirst and some suppression of urine, a weak and frequent pulse, and often cramp, extreme prostration, and, it may be, collapse. The attack lasts from about three days to a week.

As epidemic Diarrhœa is intimately associated with conditions of filth which favour its propagation, it is the duty of the local authority and the householder to remove such conditions.

Directions for feeding Infants and precautions against Diarrhœa in Infants.

1. Infants fed by hand suffer in a far greater degree from Diarrhœa than do infants fed at the breast. This shows that infants fed by hand are infected by their food.

2. Mothers should endeavour to suckle their infants for nine months. To do so, and to keep in good health, they must have abundance of good, plain food, and maintain regular habits.

It is cheaper and safer for the child that the mother should be well-fed and suckle the child than to have the infants fed by hand.

3. An infant should not be weaned during the warm months when Diarrhœa is prevalent.

4. If a mother cannot suckle her infant, she should rather rear it on cow's milk than on condensed milk. The condensed milks usually given to infants are not sufficiently nourishing. Especially during the warm months, mothers should frequently pour out a little of the cow's milk used and taste it to see that it is fresh. When a mother is obliged

to wean her child, she should always consult a doctor as to the way in which the cow's milk is to be prepared for the infant.

5. It is better to have definite rules for feeding.

All vessels and utensils used in feeding the infant should be kept scrupulously clean.

When the milk has been received in the morning, the mixture which the child is to have should be made up to last 24 hours and the sugar or anything else to be added should be added at once.

The mixture, as it is to be used, should then be brought slowly to the boil, preferably in a double jacketed pan.

It should then be poured at once into a clean jug, which is to be covered with a clean cloth and at once placed in a basin of water as cold as it can be got. Should the water get warm, it should be poured out, and cold water substituted, in which the covered jug is again placed.

The clean bottle and teat are to be kept in a covered bowl or basin containing water which has been boiled.

When the child is to be fed, the clean bottle and teat are to be taken out of the basin, the proper quantity poured into the feeding bottle out of the jug, which is at once again covered and once more stood in the cold water.

The teat is then put on the bottle with fingers which must be scrupulously clean.

The feeding bottle is then stood in warm water, until, after shaking, it is just comfortably warm when put on the back of the arm, and the child is then fed.

As soon as it is fed the teat is taken off the bottle, both teat and bottle are washed in plenty of hot water and soda, and both are put back in the cold boiled water for next time of use.

6. There is strong reason to believe that the infection of Diarrhœa is carried from house to house, and planted on food by house-flies. Now flies are partial to milk, condensed milk, bread (which contains on the outer portion a sugary

matter), and also to sugar and syrup. Hence all these materials should be kept carefully protected from flies; this may be done by keeping these foods in a cupboard to which air might be admitted by a fine wire screen panel. Or a keeping cupboard may be made out of an old box with a well fitting lid, or even of a clean box turned upside down provided flies are kept out.

7. Flies are attracted to houses where there are crumbs of bread, particles of sugar, treacle, and dirt.

It will be seen how necessary it is for the safety of children to keep the house always scrupulously clean.

No infant should be kept in the same room as an older person suffering from Diarrhœa, or should be in charge of any person who has Diarrhœa, or who is caring for another child suffering from Diarrhœa.

9. There is reason to believe that Diarrhœa is not infrequently contracted from placing the infant on the floor. Older children suffering from Diarrhœa infect the floor, or other members of the family carry in infection on their feet The infant sucks its soiled fingers or clothes and contracts the disease.

An infant under 12 months of age should never be allowed to crawl on the floor.

In any case, the floor should be frequently cleaned and always immediately after it has been soiled.

10. There is reason to believe that Diarrhœa is often communicated through the common habit of rubbing the child's gums to ease them about the periods of teething. This dangerous habit should be given up.

The dummy teat also often gets soiled and may cause Diarrhœa.

An infant's gums should never be touched with the finger, a dummy teat should not be used, and the child's mouth should not be interfered with except under medical instructions.

11. Every object which the infant can touch with its mouth should be kept clean.

12. Should an infant not appear to thrive, a medical practitioner should be consulted and his advice carefully followed.

13. Any accumulation of an offensive character near a house, whether arising from defective drainage, from collection of *cutchra* improperly kept or from defective cleansing of privies and gullies, should be reported to the Dy. Health Officer of the Ward or to the Health Officer of the City. Other deposits near a house will require to be removed at once by the householder.

14. The yards should be kept clean, and the drains flushed with a few buckets of water daily.

15. The ashes should not be allowed to remain about the premises nor should vegetable refuse be scattered. Tea leaves, cabbages, fish, potato peelings, etc., should be burned in the kitchen fire. No liquid should ever be allowed to remain about the premises.

16. Where any offensive smell is perceived in or near a house the cause of which cannot be ascertained and removed, complaint should be made to the Dy. Health Officer of the Ward.

Dysentery.—Dysentery is a term applied to a group of diseases of which the principle feature is inflammation of the mucous membrane of the colon. Three types of Dysentery, correlated to three kinds of parasites, are now fairly well made out. They are :—

(1) Bacterial or bacillary or epidemic Dysentery due to the presence of Shiga-Kruse bacillus.

(2) Protozoal or amoebic or endemic. Entamœba Dysenteriæ (E. hystolytica).

(3) Sporadic due to Bacillus coli communis and other causes. The epidemic form is due to impure water, wind-borne dust, fly-borne infection, personal uncleanliness or of latrine origin.

The spread of Dysentery is due to infected food, milk or water, or a human being, convalescent from the disease, introducing the infection into a community.

Measures for prevention are on the lines indicated above isolation of the patient, protection of the food and water and strict sanitation.

Sprue.—By the term *Sprue* is understood a peculiar and very dangerous form of chronic catarrhal inflammation of the whole or part of the mucous membrane of the alimentary canal, associated with disturbance of the functions of glandular organs subserving digestion.

It has been called "tropical Diarrhœa," Ceylon sore mouth, psilosis linguæ.

The disease never appears epidemically and is not contagious.

It is a disease of similar nature to Dysentery ; little is known about the special organism in connection with it, and the same precautions are necessary.

In the event of Diarrhœa or Dysentery appearing as an epidemic, the water and milk should be examined for pathogenic organisms, and the source of the supply enquired into.

The milk supply of India is such a constant source of danger that none should be used without boiling or sterilizing.

ENTERIC (TYPHOID).

It was formerly thought that Enteric did not occur amongst natives of India ; at any rate the disease is not so prevalent as it is amongst Europeans.

The reasons given are, difference in the anatomy of the intestines and their structure, due possibly to the nature of food and habits, surroundings and the food itself and prolonged association with dirty food and water. (Roberts);

In towns, where the natives live on a more mixed diet and are exposed to infection, Enteric is common enough as the result of prosperity and the desire for other forms of food.

The number of cases reported in the Indian Army is increasing, but this may be due to better knowledge and more accurate diagnosis and investigation.

Enteric Fever is due to the introduction of a special organism, Bacillus typhosus (Eberth), and possibly Bacillus para typhosus, through the medium of food, milk, water, dust, or by personal infection through the stools or urine of a person convalescent from the disease.

Food may be infected by flies or insects ; rats and mice may carry the Bacillus from infected excreta ; infected dust may be blown on the food, milk or water.

The great factor now is considered to be the *"human carrier,"* that is, persons who have recovered from the disease may infect those with whom they or their excreta come in contact ; this infection may last for several years. A *' bacteria carrier '* is a person upon whom we find pathogenic germs after a space of time exceeding by far the average time of convalescence known for that respective disease.

Foster gives the following figures :—386 cases investigated, 20 per cent. were due to infection from human carriers, 30 per cent. to infection from contact, 12 per cent. indefinite, and the remainder to infection from dust, food or water.

There is little or no doubt that the ' carrier ' commonly spreads the disease by means of his hands. There is the greatest possible likelihood of soiling the fingers in the act of micturition, as far as males are concerned ; though, urinary carriers are more often met with amongst members of the female than those of the male sex. Similarly, some degree of soiling of the fingers is a very likely accident after the act of defecation, and it is in connection with these possibilities that certain preventive steps must be associated, as far as the individuals themselves are concerned.

Enteric carriers may be (*a*) Acute, or (*b*) Chronic.

(*a*) Acute carriers may be :—(1) Persons in the incubation period of an attack. These have acquired their infection with the B. typhosus and have been proved to excrete the organisms, in enormous numbers, in their urine and fæces, for some 14 days or so before they have any reason to suspect anything wrong. (2) Persons suffering from the Enteric Fever attack. Two classes of cases are now recognized which, unsuspected, may cause spread of the disease: the "*atypical*" case, which not infrequently occurs in children; and the "*ambulatory*" case where the individual has the disease so slightly that he does not find it necessary to go to bed, but continues to carry out his daily occupation right through the attack, with the possible exception of a day or two indoors.

(*b*) Chronic carriers :—(1) Persons who have at some time or other suffered from an attack of Enteric Fever, recognized or otherwise, and have harboured the B. typhosus about their body constantly or intermittently ever since. This occurs in from 2 to 4 per cent. of all cases. (2) Nurses and others who have been in attendance upon cases of Enteric Fever and who have not contracted the disease, yet in whose excreta B. typhosus is found in large numbers.

Disposal of carriers.—In the Army, the method of dealing with Enteric convalescents is as follows :—Examinations of urine and fæces are made on four successive days at intervals of a month. In the event of three of these monthly examinations proving negative, the individual is released from observation and all restrictions, though a final examination is made after a lapse of a further six months. If he is found to be a carrier after a period of observation (in England not exceeding three months), he is discharged from the service, unless he elects to remain in hospital for treatment. If discharged, notification is made to the Medical Officer to the Local Government Board and to the Medical Officer of Health for the district in which he intends to reside.

In investigating into the cause of an outbreak of Enteric, the following points are to be considered :—life-history of the first case, how long he had been living in the place, where he was first attacked, if he had been exposed to the disease within three weeks, and other cases had occurred,—milk, food and water-supply and possibilities of their being infected.

In India the disease is so common and the movement of the people so constant and the distances so great, that much difficulty is experienced in tracing the origin of a case.

As this disease, in its mode of access to the body and the way it is propagated, so closely resembles Cholera, when Typhoid Fever appears in a district or its neighbourhood, it might be well to issue a circular to householders, similar to the one recommended in case of Cholera. In districts where pail closets are used and in any district where practicable, a covered pail to receive excreta should be left at every house where a Typhoid patient is being treated. The pail should be charged with a disinfectant, changed daily, and the contents cremated.

Typhoid Fever, like epidemic Diarrhœa, is ordinarily most active during warm weather. As Mr. Spear remarked, in a report on an outbreak of Typhoid Fever at Pemberton, "There is much ground for the belief that the Typhoid contagion may lie dormant in the soil for prolonged periods, becoming again active during the heat of summer."

According to the report of a committee appointed by the Clinical Society of London to investigate the periods of incubation, &c., "An epidemic due to milk contamination may be expected to cease at or about the end of the second week after the arrest of the contaminated supply ; but an epidemic due to the contamination of a public water-supply may not come to an end until the end of the fourth week after the source of specific pollution has been removed. Where an epidemic can be traced to well-water, its duration may be very much more prolonged and no general statement as to the probable date of the spontaneous termination can be made."

Food, milk and water at Railway stations or *Dâk* bungalows, hotels and even private houses are so liable to contamination, that it is difficult to decide where the infection may have occurred.

A person convalescent from the disease may spread it unwittingly, strictest precautions should therefore be taken in the same way as in the case of Cholera, and everything in the sick-room of an Enteric patient should be considered infectious. The nurses should not be allowed to attend other patients until after thoroughly disinfecting their clothes, hands, &c. All bedding and clothing of an Enteric patient should be thoroughly disinfected, and all the utensils of the sick-room; while the strictest precautions as to disinfection of stools should be taken as in the case of Cholera.

Anti-Typhoid Inoculation.

Anti-Typhoid Inoculation is now largely practised with good results; Leishman quotes in one regiment of a strength of 509, 147 were inoculated, 62 cases occurred with 11 deaths, all amongst the uninoculated except 2, both of whom had refused the second inoculation: both recovered.

Summary.—In the presence of an epidemic of Enteric, the disease is spread by infected food, milk or water, shell fish, &c., dust or human carrier, infected hands or clothes, and conveyed by flies from infected latrines or trenching grounds.

The patient should be isolated, everything in contact with him disinfected, all milk and water boiled, and all food well cooked.

The house and food should be protected from flies, and any convalescent patient watched, the stools examined bacteriologically from time to time and disinfected; special attention should be paid to the conservancy arrangements, and all horse and cattle litter burnt or buried; the sewage from the village or cantonment should not discharge into a river, or near a water-supply.

There is comparatively little direct evidence as to the incubation period of Typhoid Fever. This is partly accounted for by its not being infective in the sense or in the degree that Typhus and Scarlatina are infective. Then the attack commonly comes on so insidiously, its nature is not readily recognised, and the rash is scanty and not very distinct. According to Quain's Dictionary, the incubation is probably in most cases about twenty days. The range seems to be from one day to eleven weeks. It may be taken that the disease is wholly latent for about a fortnight; then there is loss of appetite, furred tongue, headache, pain in the limbs, chilliness and regular rise of temperature from day to day. The spots may begin to appear on the fourth or fifth day, but not usually till the seventh day of the fever, or later. It is thus usually three weeks after the inception before the disease can be recognised and notified. The fever lasts from twenty-one to thirty days.

The regular chills, headache, and pains in the limbs may be absent, in which case Diarrhœa will probably be the first symptom to attract attention. The signs of invasion in this disease are generally so indefinite that the patient often remains at his ordinary occupation for days after the temperature has begun to rise, and possibly does not consult a doctor till a week has elapsed. About this time the eruption begins to appear, and continues coming out for at least a week.

During the third week the morning remissions of temperature are more marked, showing the patient is beginning to improve; or less marked, indicating that the patient is sinking into a "Typhoid state." In the course of the fourth week and for a day and two after, if the patient is to recover and escape sequelæ, the temperature gradually falls to normal. If the patient continues well for a fortnight after defervescence he may be discharged, as there is no risk of his infecting others. His infectiousness commences with his first symptom.

A person who has been with a Typhoid patient may ordinarily, but not certainly, be considered safe after three weeks' quarantine. If the person has been strictly cleanly he has run little risk of being infected.

In Typhoid Fever, as in Cholera, all matters which the patient discharges from the stomach or bowels are peculiarly infective and, where local conditions exist, can operate at a considerable distance from the sick. The patient's power of infection is ordinarily by means of these discharges tainting food, air or drinking water; and precautionary measures should, therefore, be directed at preventing such contamination. The discharge cast without previous disinfection into a drain, cesspool or midden infects the excremental matters with which it mingles. The discharge also infects bedding, clothing, towels, etc., which it soils and renders, if not efficiently disinfected, liable to spread the disease to places in which they are sent to wash. It follows that by leakage from a drain or cesspool, or by cast-out slops or washing water, infective material may get access to wells or other sources of drinking water, and impart to enormous volumes of drinking water the power of propagating the disease.

When, therefore, a Health Officer is investigating an outbreak of Typhoid Fever, he will bear in mind that the source of infection may be :—

(1) A polluted water-supply.

(2) Milk, directly polluted with discharges of patient or to which specifically polluted water has been added for adulteration or for washing cans.

(3) Other food, shellfish, directly or indirectly polluted with discharge of patient. House flies may convey the discharge to milk and food.

(4) Clothes fouled with discharge of patient. Such clothes may retain the infection for a long time—two or three months probably.

(5) A previous case acting as a carrier.

It is just conceivable that the source of pollution may be portions of discharge dried and carried in the air as dust. In any case the infection will not be conveyed far in this way.

An imported Typhoid case will not serve as a source of infection if he is attended to in a proper and cleanly manner. However, to ensure this, initial cases should if possible be isolated in hospital, and great care should be taken in disinfecting and cleansing infected clothing, bedding, etc., and premises.

Instructions for Disinfection.

Typhoid Fever or Enteric Fever is conveyed by the ingestion of some article of food or drink which has become infected with the Typhoid bacillus. Water, milk, vegetable, shellfish, ice-cream, etc., may all serve as media for the bacillus to retain its infective character. Flies have been proved to convey the germs of Enteric and other diseases to food and a frequent source of contamination is the eating of food without preliminary washing of the hands after contact with a patient suffering from Typhoid or with infected clothing.

It is most important, therefore, that the Inspector should faithfully carry out the following rules :—

1. All infected or *soiled personal linen, etc.*, and bed clothes should be at once placed in a solution of *izal fluid* and allowed to remain there until the disinfection of the house is completed. On the completion, the clothes should be removed to the van and taken to the steam sterilizer.

2. The mattress, if any, should be removed to the steam sterilizer.

3. The walls, floor, door and seat of the privy should be thoroughly washed with izal solution. This must be done most carefully and thoroughly as the risk of infection being conveyed in this way is considerable.

4. It is specially important that all utensils used by the patient for eating or drinking should be thoroughly *washed in izal fluid* and then in pure, clean water.

5. The walls, doors, floor and ceiling of the room or rooms should be washed with perchloride of mercury solution, care being taken to prevent dust rising and thereby increasing the risk of the disinfecting gang contracting the disease.

6. All water taps should be carefully washed with freshly prepared permanganate solution and the water allowed to flow freely for a few minutes afterwards.

7. Careful search should be made to see if any well exists on the premises. If so, then it must thoroughly be treated with permanganate of potash solution.

8. If the privy is on the basket system, the Disinfecting Sub-Inspector must make arrangements for the complete disinfection of the iron receptacle with izal and the thorough cleaning of the privy trap and trap doors. This should be done under his personal supervision, to lessen the risk of conveyance of infection by flies. After thorough cleansing the whole trap should be treated with pesterine.

TYPHUS FEVER.

Typhus Fever is very rare in India. Dr. Bristowe, who is a recent writer, and has had much experience, puts the incubation period of Typhus at from five to twenty-one days, or even more. The onset is generally rather sudden, a feeling of chilliness, fatigue and malaise being quickly followed by intense headache, all the indications of high fever, and often delirium in a few hours. From the commencement of the indisposition to the appearance of the eruption (consisting often of a few not very distinct spots) is usually about a week; thus, from the inception to the beginning of the eruption may be counted twenty days. In fourteen days from the beginning of the fever, or seven days from the first appearance of the eruption, the formidable symptoms subside, and the temperature is normal. Ten days or a fortnight afterwards the patient may be convalescent, free from infection, and fit to be discharged. Thus a crisis may be looked for after a week of fever or two or three weeks. A Typhus patient is very infectious from the onset to the end of the fever and till he has been efficiently cleansed.

The incubation period in Typhus is so uncertain that after a person has been exposed to infection, it is not practicable to quarantine him for a definite period and then pronounce that he is safe.

BERI-BERI.

Beri-Beri is a specific form of multiple peripheral neuritis occurring endemically, or as an epidemic. The mortality is considerable, death usually depending on heart paresis.

The cause of this disease is unknown ; several theories have been put forward, the most favoured being that of uncured rice ; possibly, some micro-organism in certain forms of food producing a toxin.

It occurs in overcrowded damp places, asylums, gaols, and chiefly attacks people living on the ground floors, and is endemic in places—often in ships.

People when removed from these surroundings generally recover. Prevention of the disease appears to lie in sanitation of endemic areas, and attention to the food stuffs, with early removal of the patient from the affected locality.

TUBERCULOSIS.

Tuberculosis means the changes taking place in the animal body when it is invaded by the organism called the "Tubercle bacillus."

The Tubercle bacillus discovered by Prof. Koch in 1882 is an organism capable of living, not only within, but also outside the animal body ; it may be cultivated on various artificial media. Like other organisms it exhibits certain morphological characters, which may be observed by means of the microscope ; it grows and multiplies in certain ways, and possesses certain physiological properties through which it acts upon and is acted upon by its environment, whether that environment be a living animal body or a lifeless artificial medium.

Tubercle bacilli, when stained with carbol fuchsin, are seen to be delicate cylindrical pink rods, slightly curved or straight, with a granular appearance ; they are "acid fast," that is, when stained and treated with acid, they retain the original stain. The difference in the microscopical and morphological appearance of human and bovine Tubercle bacilli is very slight. What difference there is, is cultural and one of degree only.

Tuberculosis occurs in many, if not all, of our domestic mammals, in the ox, pig, horse, sheep, cat, dog and others.

It has also been observed in many wild mammals, the monkey for instance, when kept in captivity. A disease called Avian Tuberculosis is known to occur in certain birds; and reptiles have been described as suffering from Tuberculosis. Hence the phrase Tuberculosis in "animals other than man" opens up a very wild field of inquiry.

The principal form in which Tuberculosis affects man is "Pulmonary Tuberculosis," "Phthisis," or "Consumption"; but all parts of the body may be affected as in Tabes Mesenterica, Tubercular Meningitis, and Tuberculosis of the Joints and Organs.

Tuberculosis may be spread from man to man, by the inhalation of dust containing Tubercle bacilli, or by direct infection from the sputum, also by infected milk and meat and by flies.

At the British Congress on Tuberculosis in July 1901, Prof. Koch said that Bovine and Human Tuberculosis were different; that the former could not be transmitted to man except under exceptional conditions; and that precautions against Bovine Tuberculosis were not necessary. This came as a thunder-clap to the medical world, and the result was a Royal Commission appointed in 1901: from the Report published it has been shown that there is very little difference between the Tuberculosis of cattle and man, and that thay can be transmitted from one to the other.

The Royal Commission state that the cases of Tuberculosis and the Tubercle bacilli found in the intestinal glands of children were similar to those of Bovine Tuberculosis, and the disease was due to infection by food and milk.

There can be no doubt but that in a certain number of cases the Tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of Bovine Tuberculosis, and that, in the majority at least of these cases, the bacillus is introduced through cow's milk. Cow's milk containing Bovine Tubercle bacilli is clearly a cause of Tuberculosis and of fatal Tuberculosis in man.

A very considerable amount of disease and loss of life, especially among the young, must be attributed to the consumption of cow's milk containing Tubercle bacilli.

The Tubercle bacilli may be present in the milk of cows which are otherwise apparently healthy; they are found in large numbers in the fæces of infected cows.

Shröeder in an interesting paper states that 40 per cent. of the dairy cows, that retain the appearance of health and are not known to be affected till they are tested with tuberculin, actively expel Tubercle bacilli from their bodies in a way dangerous to the health of other animals and persons; that a considerable proportion of the dairy products is infected with Tubercle bacilli owing to the frequency with which cow fæces are found in milk: for it has been proved that the commonest way for Tubercle bacilli to pass from the bodies of Tuberculous cows is with their fæces, and once milk is contaminated with Tubercle bacilli, the latter enter the various articles of diet prepared from it, and are specially numerous in butter, in which they may remain alive seven weeks or longer without diminishing in virulence. The practical importance of this is that herds of Tuberculous cattle can be cleaned by the periodic application of the tuberculin test.

These results clearly point to the necessity of measures more stringent than those at present enforced being taken to prevent the sale or consumption of the milk of Tuberculous cattle.

Bovine and Human Tuberculosis.

It is now definitely settled that Tuberculosis in cattle may and does cause Tuberculosis in man, and this is especially important with reference to the disease in children in India.

The interest taken in the cause and control of this disease in England, France, Germany, America, Australia and other countries of the world and the investigations undertaken by them have tended to reduce the incidence of the disease considerably.

But in India little has been done to ascertain whether the conditions which obtain in other countries exist here, or how they may vary.

It is generally assumed that Bovine Tuberculosis is rare in India and with a view to ascertain the truth some investigations were undertaken by the Executive Health Officer, Bombay.

Work done in India.

In considering the possibility of children in India contracting Tuberculosis, both general and pulmonary, from Tuberculous cattle—either by milk or infected fæces and also by milk infected by human agencies—the following questions present themselves for solution :—

(*i*) Whether cows or buffaloes in India suffer from Tuberculosis.

(*ii*) Whether milk could be infected from human or bovine agencies, after it had been drawn from a healthy animal,—by the habits and customs of the attendants and by infected fæces.

(*iii*) Whether the human being, especially children, could not contract Tuberculosis, because of the intimate relation of the working classes with cows, bullocks and buffaloes, and the enormous use made of cowdung, some of which must be infected.

Examination of samples of milk and human sputa.

To ascertain the truth, the examination of samples of milk and human sputa from milk shops and milch cattle stables in the City were undertaken in Bombay at the Municipal Laboratory by Dr. Ghadially and Dr. Joshi.

The milk was collected from different milk shops by the Deputy Health Officers of the Wards in sterile glass bottles and sent to the Laboratory ; 20 c. c. of each sample were centrifuged and the sediment examined and if acid fast bacilli resembling Tubercle bacilli were found, the Deputy Health Officer was asked to trace the source of milk.

This was not easy, as the milk sold at the retail shop is mixed ; only in 6 cases could the infected milk be traced to cows. Milk of these cows was then drawn into sterile glass bottles and again examined and a positive result obtained in the case of all the six cows.

Tuberculin test.—The animal is first allowed to become cool and quiet ; then the temperature is taken per rectum, the thermometer being allowed to remain in for 5 minutes. The *normal temperature of bovine animals is from* 100·5° *to* 102·5° F. It is convenient to inject the Tuberculin into the neck or shoulder, late in the evening so that the observation of the reaction temperature may be made early next day. The animal must not be regarded as certainly Tuberculous unless the morning temperature shows a rise of at least 2·5° F. above that of over-night.

The test should not be repeated until at least a month has expired.

All the six cows were treated with Tuberculin : four of them reacted 2·5 and two only .7.

Milk of these four cows was injected subcutaneously into guinea-pigs with no result.

In all 217 samples of milk were examined, of which 9 were repetitions ; thus out of 208 examined, an acid fast bacillus was found in 30 or 14·4 per cent. ; of these 9 were traced to cows and tested with Tuberculin and 6 reacted.

A *post-mortem* examination could not be made. Much difficulty is experienced in getting permission even for testing with Tuberculin.

In all, 105 cows and buffaloes were tested with Tuberculin :—

34 at Bandra Slaughter House—none reacted.
5 buffaloes and 31 cows at Panjrapole—2 cows reacted.
26 cows privately—3 reacted—no *post-mortem.*
9 buffaloes privately—no reaction.

The fæces of the two cows reacting to Tuberculin were examined and found to contain an acid fast bacillus of the same type as in milk.

On *post-mortem* examination of these cows, no Tubercle bacilli could be found in any of the organs, but cystic degeneration and cysts were plentiful.

To find Tubercle bacilli in milk, unless the animal is suffering from acute Tuberculosis of the udder, is difficult and requires care ; other acid fast bacilli may be present, and to differentiate, the infected milk must be inoculated into a guinea-pig. This, however, is not always decisive as milk may contain very few bacilli and then no reaction takes place.

This process was followed on nine occasions with no result. The Tuberculin test when followed by a high and maintained rise of temperature is considered sufficient evidence of Tubercle in cattle, which can be verified by a *post-mortem* examination. Unfortunately this could only be carried out on two occasions—with a negative result.

The other three cows reacting to Tuberculin lived and have calved since ; on re-inoculating them 3 months later no reaction occurred.

In 30 cows selected at Bandra Slaughter House as looking suspicious of Tuberculosis, Tubercle bacilli were found only in the organs of one—brought for slaughter at Bandra Slaughter House. The acid fast bacillus found in the milk was not Tubercle.

Samples of human sputa collected from bathing places, washing places for cows and buffaloes, and from milk shops and the streets were examined for Tubercle bacilli.

Out of 271 such samples examined, 33 or 12 per cent. contained Tubercle bacilli : the object in examining the sputa was to ascertain, if possible, whether the milk could be infected in that way.

Milch Cattle Stables and Attendant Evils.

Any one with any experience of milch cattle stables, dairies and milk shops in India, and the habits and customs of the *gowlies,* their methods of milking and of washing themselves and their milk vessels, can easily appreciate that milk could be infected in this way, and that possibly the samples examined may have become infected by human agency and not bovine. The results of the Tuberculin test and *post-mortem* examination of the cows tested, however, showed that this could not be the only source of infection. The results of the Royal Commission, moreover, prove clearly that the fæces of the Tuberculous cow are loaded with Tuberculous bacilli, and a visit to a milch cattle stable in Bombay will readily show how this may be a possible means of infecting milk.

Facilities for Transmission of Tubercle bacilli.

The milk-vessels are cleaned with cow-dung and dirt, the buffaloes and cows wallow in their excrement and the buffaloes are washed at the same place and well as the milk vessels are cleaned at, and with the same water.

This, then, is a common way of infecting milk and is peculiar to India ; because in England and Europe the value of the cleanliness of the cow and the utensil are much more appreciated, and the regulations concerning the milk supply are much more strict ; although the buffalo is washed regularly in some stables in India, its surroundings and the habits of its attendants are much more insanitary.

Again, the traffic in cow-dung is enormous. Cow-dung mixed with urine and mud is used for plastering walls and floors and roofs of houses ; it is stored in the house.

Even in large cities, the cow and bullock are inmates of the dwelling house, and all the cooking pots and vessels used are scoured with cow-dung and dirt from the street.

The facilities then for the transmission of the Tubercle bacilli from animal to man are greater in India, because of the intimate connection between them.

Fortunately, the climate has some influence on the life of the bacilli, and the exposure to the heat of the sun checks the growth ; but the dust of streets, where there is so much of bullock traffic, must contain a large number of Tubercle bacilli, while flies and dust must convey the infection to food and milk.

Again, it is a very common sight to see crows eating sputum in the streets or stables ; to see crows, after picking up sputum, fly to a milk or water vessel and dip in their beak, or pick the meat and fish in the market, or from the open basket on the head of a cooly, or drink milk out of milk vessels in the stables or open cans in the streets or shops.

Results of Investigation in Bombay.

In Bombay City there are 1,985 cows, 17,328 she-buffaloes and 22,817 bullocks.

The results of the investigation are (*i*) that cattle in Bombay, and presumably other parts of India, do suffer from Tuberculosis to a slight extent ; (*ii*) that it is possible for milk to be infected by human agency owing to the habits and customs of the attendants and the methods of distributing milk ; (*iii*) that a possible source of infection is the fæces of infected cattle—due to the intimate connection between the labouring class and the cattle and the enormous use made of cow-dung in the houses and surroundings.

It is not meant to suggest that Tuberculosis in India is caused only by infected milk or food ; but that it is one cause which has hitherto not been investigated. Nor is it maintained that the experiments carried out cover the whole ground, or are complete, or free from the possibility of error, but with the pressure of other work in a very large and busy Department, complete research cannot be undertaken: they are, however, sufficient to warrant further inquiry and more stringent regulations regarding the milk and food supplies in India.

Statistics show that the mortality from Tuberculosis is higher in India than in England; the milk and sputa examined show that there is risk of disseminating the Tubercle bacillus, while the presence of this bacillus in the fæces of infected animals is a greater danger in India than in other countries. The argument that all milk is boiled before being used is applicable to any milk-borne disease; but the majority of people would prefer to know that the milk comes from healthy animals and is pure.

Sanitation and education in sanitation and the application of sanitary laws and regulations, and sanitary surroundings are of great importance in Tuberculosis as in Malaria and Plague and all other communicable diseases. Every preventive measure should be availed of and all milk should be boiled.

Practical Precautions and Measures.

To thoroughly undertake the work of controlling and exterminating Tuberculosis in a community, much time, trouble and energy are required with a perfect organization and thorough control and suitable bye-laws and regulations. A perfect routine system will have to be followed, beginning with compulsory notification of every case by the medical man in charge or by direct inquiry by a specially qualified Medical staff, male and female, also by Health Visitors and Nurses.

Early Notification:—On receipt of a notification or information of a case or of a certificate of death from Phthisis, or as the result of examination of sputum sent to the Laboratory, the Sanitary Officer should visit the house, making inquiries into the duration of the case and its surroundings. Instructions should be given, printed and oral, and the case, if possible, removed to the Hospital for Consumptives. He should then proceed to disinfect the room and bedding. The Esmarch process of rubbing the walls, ceiling and floors with dough to collect the infected dust might be adopted in suitable houses, as it would not be practicable in all Indian dwellings; the dough should afterwards be burnt; on no account should the room be swept with a brush or duster, as the infected material may be dispersed in the air and inhaled by the operatives.

Formalin spray or 2 per cent. solution of chloride of lime or izal 1-30 may be used for washing the floor, walls and ceilings. The furniture should be washed with a damp cloth soaked in izal. The linen and bedding should be passed through a steam sterilizer. A room occupied by a Phthisical patient should be thus treated every 6 months.

Regular forms should be kept and a register made of all cases visited and of action taken.

Improvements in dwellings, Town Planning and ventilation of houses and areas should be enforced, thus raising the social and domestic condition of the poor.

Hospital accommodation, Sanatoria and Consumption Dispensaries should be provided—by the Municipality, the State or charitable persons and privately.

Inspection of meat and milk dairies, cowsheds, slaughter-houses, and of the overcrowding of workshops and factories should be systematically carried out.

All milch cattle should be tested with Tuberculin and such as react to the test should be removed; legislation should be adopted for compensation and slaughter of infected animals. All infected animals should be cast and destroyed.

Complete control of the milk-supply by the State is necessary: ensuring the removal of dairies from the centres of large towns and cities; cleanliness in the collection of milk and the transmission of it from the dairy to the consumer.

Notification of births within twenty-four hours should be made compulsory.

Medical inspection of school children and school premises, factories, workshops and of infected houses by medical men and Health Visitors should be carried out to ensure sufficient sanitary arrangements.

Advanced cases should be segregated in Hospitals. Notices as to spitting should be widely circulated in all public places, workshops, factories, common lodging houses, vehicles, railways, tramcars. Spitting is controlled in Europe and America and should be controlled in India.

Measures carried out in Bombay.

Leaflets in English and Vernaculars are freely circulated and lectures delivered and notices against spitting issued to all schools and public places.

Cases of Phthisis are notified to the Health Officer, and the houses are disinfected and lime-washed; 2,085 cases were notified and 2,365 houses disinfected on account of the disease in 1912.

The King George V. Anti-Tuberculosis League has founded a Tuberculosis Dispensary and a Bureau of Information—both in conjunction with the Health Department.

Plan of Campaign.—The League proposes to restrict its efforts to measures for the prevention of Tuberculosis in its varied manifestations, and with this view, it has devised the following plan of campaign, (which is subject to modification as required), as the best suited to local conditions and most likely to ensure early and adequate results :—

(1) Notification of Disease.
(2) Tuberculosis Dispensaries.
(3) Education of the People.
(4) Medical Inspection of School Children.
(5) Supervision of Milk and Food Supplies.
(6) Special Fund to Relieve Distress.
(7) Arousing Public Interest in Tuberculosis.

(1) *Notification of Disease*—

The cordial co-operation of the Department of Public Health and medical practitioners in the City by notifying cases of Consumption, and thereby placing the poor and needy in touch with the Dispensaries is essential for the purpose of preventing the dissemination of infection.

(2) *Education of the People*—

(*i*) Education of the general public and the working classes, with a view to the better understanding of the nature of Consumption, the risks from infection, the methods of guarding against the same, etc., and their practical demonstration will form the principal basis of preventive and educative work. That will be done by domiciliary visits of the Medical Officers and Nurses attached to the Dispensaries, and, if possible, by the co-operation of a Ladies' Committee of Voluntary Workers, as in London and Dublin, who will also help and supplement the work of the paid staff.

MALTA FEVER OR MEDITERRANEAN FEVER.

Malta Fever or Mediterranean Fever is a specific infectious fever of extended duration and frequent relapses, characterised by copious diaphoresis, and frequently accompanied by articular rheumatism and orchitis. Incubation period varies from 5 to 15 days.

A special bacterium, *micrococcus melitensis,* is found in the spleen and lymphatic glands of these patients. It is excreted in the urine, and it occurs in great abundance in the milk and urine of apparently healthy goats in Malta (50 per cent.) and cows, and in the urine of apparently healthy man.

In Malta and other places, where the disease is endemic, this fever assumes an epidemic character.

Mode of Infection.—It is not usually directly communicable from the sick to the healthy. The germ is readily conveyed by inoculation ; the prick of a contaminated needle will suffice. Goat's milk is the most important medium of infection. In 10 per cent. of the milk of Maltese goats micrococcus is present.

Prophylaxis.—Malta and those Mediterranean ports in which this fever is endemic should be avoided during summer.

Drinking water, food and drains ought to receive special attention in the endemic area. All milk should be avoided, or sterilised by boiling. Every care should be taken to avoid insect bites and other skin lesions.

The therapeutic employment of *vaccines* of dead M. melitensis prepared and administered according to Wright's methods has been favourably reported on.

When possible, a subject of Mediterranean Fever would do well to avoid the endemic area for one or more years after recovery.

PLAGUE IN INDIA.

The present epidemic of Plague in India was first noticed in Bombay in August, 1896. In spite of all attempts to prevent it, it spread all over the island, and from the island to the mainland. The disease may be said to have become indigenous in Bombay from 1897. In 1898 a Plague Commission was appointed to enquire into the cause, &c., of the disease. The Commission spent four months in India and returned to England, and in 1901 issued a Report on their investigations.

Evidence was taken from every one in India who was considered to have had any experience of the disease. In addition to this Commission, deputations were sent from Austria, Germany, France, Russia, Turkey and other countries to investigate the disease. The inquiries have all been published, and comprise much that is of value. But the actual results of this Commission, so far as controlling the disease or throwing any light on its origin, its method of infection and measures to prevent its spread in India are concerned have been practically nil, as evidenced by the virulence of the disease during succeeding years in India.

The present Plague Research Commission, appointed in 1905, publishes from time to time the results of its investigations and constantly produces new and interesting material bearing on the subject.

Major Liston, C.I.E., I.M.S., Director of the Bombay Bacteriological Laboratory, and Senior Member of the Commission in India, has published Memoirs on Plague Prevention and Inoculation, which are very valuable contributions to the literature on the subject.

Col. Browning Smith, I.M.S., working independently in the Punjab, deals with the prevention and epidemiology of the disease, while Capt. Kunhardt, I.M.S., also on the Commission in Bombay, has contributed some interesting notes on the epidemiology of the disease in villages.

To get an insight into the completeness of the investigations made their Reports should be consulted.

Introduction into Bombay :—How the disease was brought to Bombay in the first instance is still unascertained. Several theories have been advanced, the most important being as follows :—

(1) The disease may have been brought to Bombay by sea from Hongkong or from the infected parts in Southern China.

(2) It may have been conveyed from the Persian Gulf, the disease being endemic in Mesopotamia.

(3) The infection may have been carried from Kumaon and Garhwal Hills to Bombay by pilgrims.

(4) Another theory is that it was brought by pilgrims from Jeddah. It has been suggested that the infection may have been carried by rats, merchandise, infected clothing, food and grain.

(5) A reference to the map of Southern China, India and Arabia will be of interest with regard to the theories suggested. It will be seen that in August, 1896, Plague first appeared in Bombay after an interval of 200 years. Plague was reported in Hongkong in 1894, 1895 and 1896 ; also in Arabia and China in 1893, 1894, 1895 and 1896.

Bombay is a large and important port and city on the west coast of India, and in constant communication with Arabia and the Persian Gulf and the Red Sea Coast, Assyr, &c., where Plague is endemic.

The disease first appeared at Bombay and spread inland to India, west to east. The disease did not come overland across the continent of India to Bombay. It is reasonable then to assume that it was introduced by shipping. The trade between Bombay and Hongkong is small, compared with the other Indian Ports, as Calcutta, Rangoon and Singapore, &c. Ships trading between Hongkong and Bombay touch at many ports before reaching Bombay, but no history of Plague is known previously at any of the ports of India and Burma, previous to the outbreak of Plague in Bombay in 1896, nor did Plague appear at any city inland between Kumaon and Bombay. It appears therefore more than probable that the disease came from the Persian Gulf or Arabia, being brought either by pilgrims who come and go to the extent of 20,000 per annum, or merchandise or grain, rats or vermin. The disease appeared first in grain merchants' quarters near the Docks.

Once introduced into Bombay with its large population, all conditions were ready for its rapid diffusion.

Plague, thoroughly established, thrives when suitable conditions are found for its sustenance, and when the people are overcrowded in dark, dirty, ill-ventilated, badly lighted houses ; when the houses and rooms are so dark as to require a light in the day time, when the sick and the healthy live together, when the conditions of climate, atmosphere and temperature and moisture favour its propagation, and when the habits and customs of the people prevent measures being taken to prevent the spread of the disease ; when the floors, walls, ceilings and collections of rubbish in houses form a suitable rendezvous for rats, fleas and all sorts of vermin ; when the primitive method of night-soil removal and drainage facilitate the accumulation of filth and garbage, and provide a happy hunting ground and food supply for rats.

The incidence of Plague follows closely insanitary surroundings, absence of domestic, personal hygiene, overcrowded insanitary areas, want of ventilation and light and the presence of filth—in fact, the incidence of disease is directly related to the insanitary domestic surroundings which harbour rats.

Sanitation and Plague.

Sanitation, properly applied, influences the spread of Plague. Sanitation is the result of bacteriological, clinical and epidemiological investigation into the cause of disease, and embraces the whole of practical, preventive medicine as well as the every-day work of practical sanitation. It is not for a moment suggested that the insanitary surroundings mentioned are the cause of Plague; but the insanitary condition of the people, due possibly partly to poverty and ignorance, is the cause of the persistence of Plague; that Plague is now practically confined to that class, and that when it is contracted by those who pay more attention to sanitation, the disease is easy to control.

Sanitation includes not only the provision of sanitary houses and streets and proper method of drainage and water-supply, but every thing which tends to improve public health and to prevent the spread of disease, including investigation into the causes of sickness and death, the provision of hospitals, medical relief, Health Visitors and instruction in personal hygiene and the spread of knowledge of the cause of disease.

The development of sanitation and its effect on the health of the people during the past fifty years has been very marked, and is nowhere more striking than in the investigation into the cause and prevention of the spread of infectious diseases such as Yellow Fever, Sleeping Sickness, Malaria, Plague, Diphtheria, Small-pox, Enteric, &c.

Conveyance of the Disease:—Certain diseases may, and doubtless do, depend upon highly specialised obligate parasites, incapable of thriving except in the tissues of hosts. Such organisms, though themselves a product of evolution, may have been evolved in the remote past under conditions of environment never since, and perhaps never again to be, reproduced.

Notwithstanding, therefore, that all pathogenic micro-organisms are doubtless, especially as regards their pathogenic function, subject from time to time to minor variations within the limits of the species, yet many species of such organisms may have long since attained a high degree of fixity of type, and thus exhibit now but little tendency to variation beyond such limits. That such is actually the case with regard to the microphytic causes of some of the diseases, there seems ample epidemiological evidence to show.

In this connection it is important to note that occasional difficulty in tracing particular attacks of a given disease to previous cases is far from justifying hasty conclusion that such attacks have had another origin. The probability of such being the case must depend upon a comprehensive view of the ascertained facts, with regard to the disease in question at least, that is, pending definite knowledge of the life-history of the microphyte upon which the disease depends, the multifarious ways in which infection may have been carried and the difficulty of tracing its carriage by man: such ways must be fully taken into account. Allowance must also be made for errors of diagnosis, untreated and concealed cases, which largely add to the difficulty of following out the casual association between successive and connected attacks. If this difficulty is met with in the early cases of an outbreak, the possibility of tracing back the outbreak to some previous prevalence in a more or less remote neighbourhood, to which it may in reality have been due, is entirely prevented.

Certain diseases appear to have special seats or points of invasion, that is to say, the viruses upon which they depend usually attack the body by some special channel or channels, and possess little, if any, ability of primarily establishing themselves elsewhere. This appears to be the case with regard to the poisons of Diarrhœa, Cholera and Enteric Fever, which make their assault upon the intestinal mucous membrane, and with regard to the poison of Pneumonia which attacks the lungs, and Diphtheria which attacks tonsils and throat.

These facts are of considerable importance with respect to the spread of such diseases, for it is not sufficient, in cases of the kind, that the poison should simply be brought to the body, but it must be conveyed also to the particular part of the body which is vulnerable to it. Here we find an analogy in the behaviour of the parasitic fungi which produce the diseases of plants. Some of these attack the flowers some the fruit, and some the roots.

Take for instance Enteric or Cholera; we know that these diseases are caused by a poison introduced directly into the intestinal canal either by mouth or rectum. We know that the food or water-supply is infected directly or indirectly from a previous case of the disease by these channels, and this knowledge has enabled us to prevent the spread of these diseases by sanitary precautions outside the dwellings; with regard to Plague, we have no such knowledge to guide us. In fact, up to a short time ago, our knowledge on this point was negative. If our view of pathology of the disease is correct, we can eliminate food and water. Bubonic Plague is a direct contagion, and contact with the body either through the mucous membrane of the mouth and thorax or other mucous membrane or by the skin is necessary for invasion, and it is this which supports the view that the personal surroundings of the individuals are the factors which contribute to the spread of Plague.

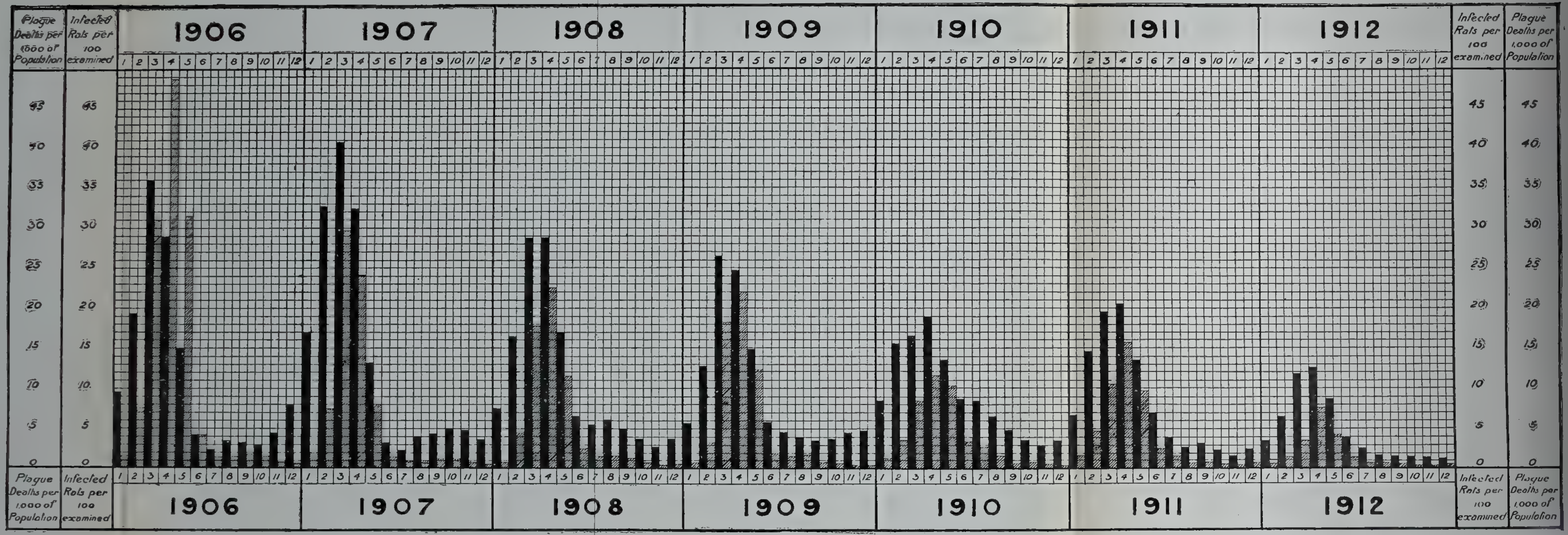
Statement showing Plague Mortality in the whole of India and in Bombay City since 1896.

Year.	No. of Deaths from Plague in India.	No. of Deaths from Plague in Bombay City.
1896	2,219	1,936
1897	53,816	11,003
1898	116,285	18,185
1899	139,009	15,796
1900	92,807	13,285
1901	283,788	18,736
1902	583,937	13,820
1903	865,578	20,788
1904	1,143,993	13,538
1905	1,069,140	14,198
1906	356,721	10,823
1907	1,315,892	6,389
1908	156,480	5,361
1909	178,808	5,197
1910	512,605	3,656
1911	846,873	4,006
1912	306,488	1,717
Total ..	8,024,439	178,434

DIAGRAM.

RELATION OF RAT PLAGUE TO HUMAN PLAGUE DURING 1906 TO 1912

(BY MONTHS).



PLAGUE INFECTION AMONG RATS ▬ **PLAGUE DEATHS IN THE CITY** ▨

Plague is a specific, inoculable and otherwise communicable epidemic disease common to man and many of the lower animals. It is characterised by fever, adenitis, a rapid course, a very high mortality and the presence of a specific bacterium, Bacillus pestis, in the lymphatic gland, viscera and blood. In a large proportion of cases buboes form in the groins, armpits or neck.

The characteristic microbe appears in great profusion in the buboes, in the spleen, intestines, lungs, kidneys, liver and other viscera and also—though in smaller numbers—in the blood. In the Pneumonic type of the disease, it is present in the sputum in enormous numbers. It occurs also in the urine and fæces.

Yersin's experiments prove conclusively that Plague is communicable by ectozoa, especially rat fleas, principally Pulex cheopis, which act as passive intermediaries and carriers of the bacillus. The Bacillus pestis multiplies in the stomach of the flea, retaining its virulence for 7 or 8 days and being passed out in the fæces ; so that the flea serves not only as a carrier, but also as a multiplier of the germs.

Recent researches by the Plague Commission working in Bombay show that Plague in man is intimately connected with Plague in rats, and that the flea from infected rats may convey the disease to man. As far back as the history of the disease goes, the rat has in some way been associated with the disease in man, and rats have been destroyed with the object of preventing it.

The following is a summary of the latest report of the Plague Commission's work. The opinion given by them just published is—

(1) That epidemics of human Plague are directly dependent on the occurrence of epidemic Plague in rats.

(2) That there is no evidence that any animals except rats play an important part in Plague epidemics.

(3) That in the great majority of cases, during an epidemic of Plague, man contracts the disease from Plague infected rats through the agency of Plague infected rat fleas.

(4) That in large towns Plague may persist throughout the year, since a few cases of acute Plague in man and rats occur during non-epidemic Plague season.

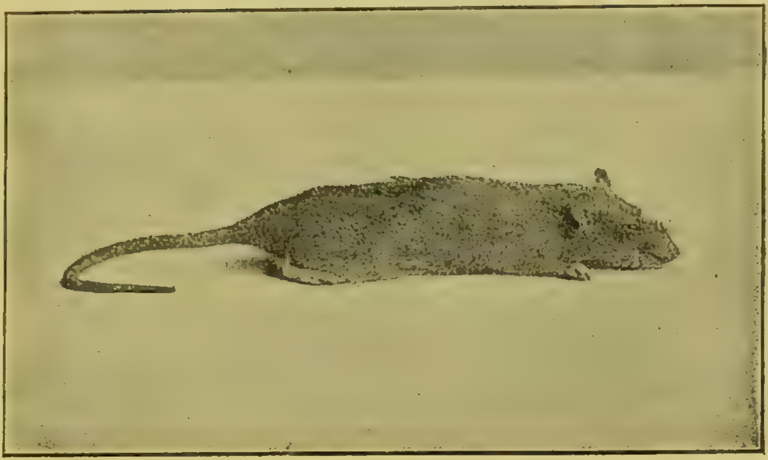
The house-frequenting rats are of prime importance, so far as Plague in man is concerned. There are at least four kinds of common house-frequenting rats met with in India, but they do not all play an equally important part in the spread of Plague. Two of these four kinds of rats we can dismiss very shortly; they both belong to the genus Nesokia—a group of rats more familiarly known as bandicoots. Before Plague was introduced into Bombay the large bandicoot was frequently seen in houses, but it is now a very rare rat in the City. Occasionally, however, the lesser bandicoot known as *Nesokia bengalensis* is met with. Among a very large number of rats found dead and caught alive in Bombay City and examined by the Plague Commission, this species constituted only 1 per cent. of the whole. The chief interest in this rat arises from the fact that it can very easily be mistaken for a more common house-frequenting species.

The Association of Rats with Men is the cause of Epidemic Plague.

If we study the causes of the association of rat. with man, we find that this depends partly on the habits of the rats and partly on the manners and customs of the people.

The habits of rats vary according to the species to which they belong.

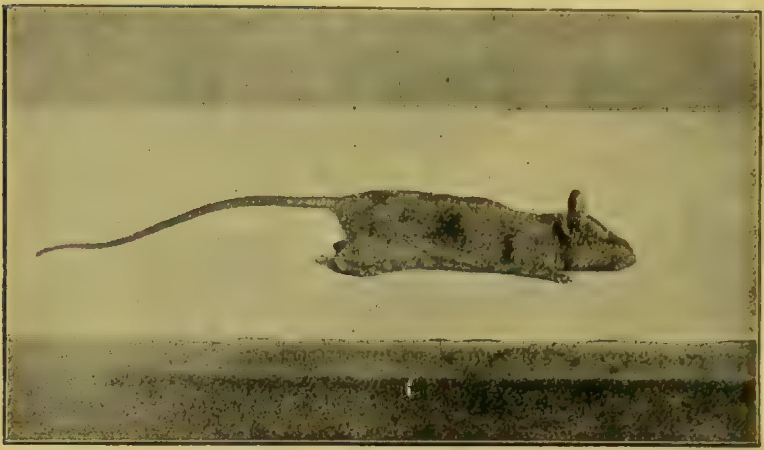
RATS.



MUS DECUMANUS.

Size.—Comparatively large. *Colour.*—Brown. *Head.*—Thick and short. *Ears.*—Small. ·*Coat.*—Rough. *Body.*—Longer than the tail. *Habits.*—Burrowing in its habits and lives chiefly in drains and cellars.

Mus decumanus has a longer and sharper snout than *Mus-rattus,* smaller ears, less bristly fur and a more hairy bi-cloured tail, the dorsal surface of which is darker than the ventral. This rat is comparatively rare in India. Indeed it is never found in inland villages, and has only recently established a footing in some of the larger Indian seaport towns It is found in Bombay City where drains and sewers exist, but it cannot be captured in the suburbs where drainage systems are unknown. *Mus decumanus* lives in burrows and drains, for the most part constructed outside of human habitations, but it enters houses for food. It feeds on garbage of all kinds, is a dirty rat, shy and timid in manner, shunning the society of man, but living upon the refuse he leaves. *Mus decumanus* has an interesting history. It first made its presence manifest in England and some other European countries coincidently with the disappearance of Plague from them. The rat is said to have been imported from Norway, hence it has been called the Norwegian rat. It gradually displaced in England another species of rat.



MUS RATTUS.

Size.—Comparatively small. *Colour.*—Dark. *Head.*—Small and pointed *Ears.*—Large. *Coat.*—Smooth. *Body.*—Shorter than the tail. *Habits.*—Prefers to live in roofs of houses and is more domestic in its habits.

This other rat, *Mus rattus,* was common in England in the early Plague period. It has, therefore, sometimes been called the old English black rat. It is the common house rat of India.

Mus rattus is readily distinguished from *Mus decumanus* by its long tail and large ears. It is a neat, clean living creature, very domesticated and constantly associated with man. It lives and breeds in human dwellings ; in cupboards, beneath boxes or among any sort of lumber. It finds ideal conditions for existence in Indian houses. Intimately associated with man, it readily finds shelter on ships and trains among the materials placed on board for transport. It frequently makes for itself burrows in the earthen floors and walls of huts in Indian villages ; there it breeds and multiplies with great rapidity feeding upon the grain and other materials stored in the house.

In the Island of Bombay there are probably three of the "sewer" rats, *M. decumanus,* to every seven of the "house" rats, *M. rattus.*

Mus rattus is a Plague-spreading rat because of its habits.

That *M. rattus* is the most important Plague-spreading rat in India has been amply proved by the Plague Commission. The Commissioners were enabled to secure for examination a large number of rats found dead or trapped alive in Bombay City. They were thus able to record each week the number and species of the Plague infected rats found. The examination and record was continued for a year, and the mean weekly number of infected rats of each species for that period was calculated. The Commission was also supplied with figures of the weekly human mortality from Plague in the City, and so was able to calculate a mean weekly human Plague mortality figure for the year.

The Plague among *Mus rattus* precedes the Plague among men by an interval of a week to a fortnight.

Rat and Plague.—The association of the rat with Plague is no new theory.

The mortality amongst rats preceding a Plague epidemic has been quoted in the history of most of the Plague epidemics for many years. Since, however, the discovery of the Plague bacillus by Kitasato, and the presence of the bacillus in the rat during the Plague epidemics, the relation of rat Plague and human Plague has been more clearly demonstrated.

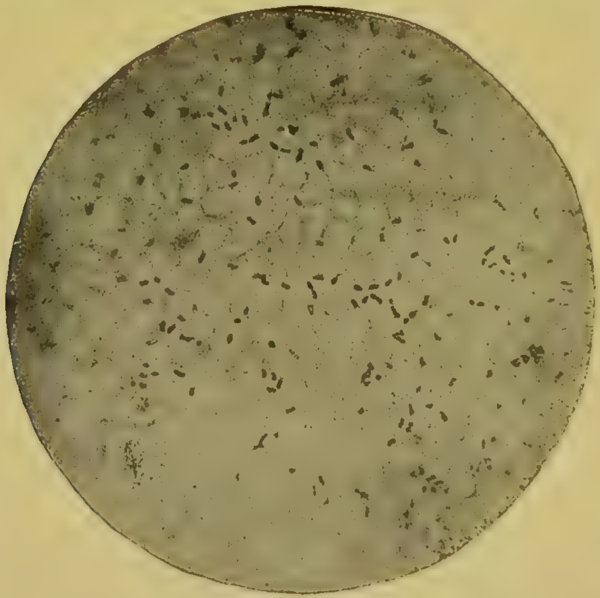
The relation of the epizootic and epidemic Plague has been carefully studied in outbreaks of the disease in Hongkong (Hunter), South Africa (Blackmore and Mitchell), Sydney (Ashburton Thompson), and other places, and was early recognised in India by Simond, Hankin, Weir, and the German Commission.

Some idea of the intimacy of the correlation between human Plague and Plague in *M. rattus* can be gathered when it is stated that it has been mathematically calculated from figures supplied by the Plague Commission that the correlation co-efficient of human Plague with the *rattus* Plague of the second previous week is ·9407 with a possible error of ± ·0096. Statisticians generally consider a correlation co-efficient very large when it is greater than ·75. We may conclude, then, that the relationship between the incidence of Plague in man and Plague in *M. rattus* is extremely close.

The Commission, as the result of exhaustive inquiries in certain small villages, where *M. rattus* was practically the only rat caught, were able to show that the correlation in time found to exist between Plague in *M. rattus* and Plague in man held good also as regards space. Where rats died, there a week to a fortnight later human cases commonly occurred. They were thus able to conclude that Plague in *M. rattus* is the direct cause of human Plague in India. It is the habits of *M. rattus*, the house-rat, that make this rat so important a Plague-carrier.

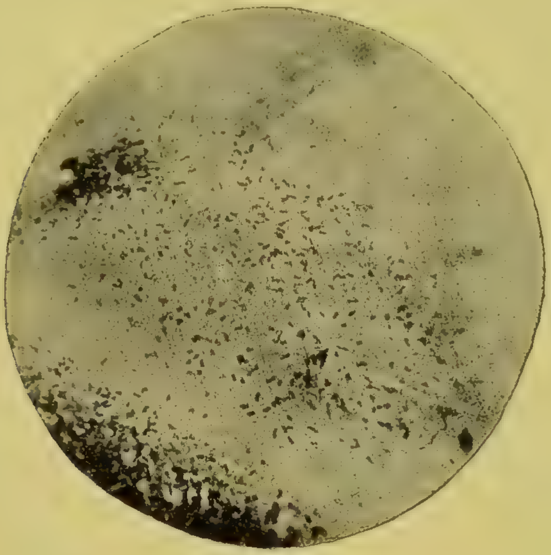
FLEAS.

The possibility of insects playing some rôle in the transfer of Plague from rat to rat and rat to man occurred to many investigators: Yersin 1894, Hankin 1897, Nuttal 1897, Ogata 1897, Simond 1898 and Liston 1903, recorded their observations that, whilst sucking, fleas were in the habit of discharging the contents of their intestines upon the skin in the neighbourhood of the puncture, and in consequence infected material might subsequently be rubbed in during the



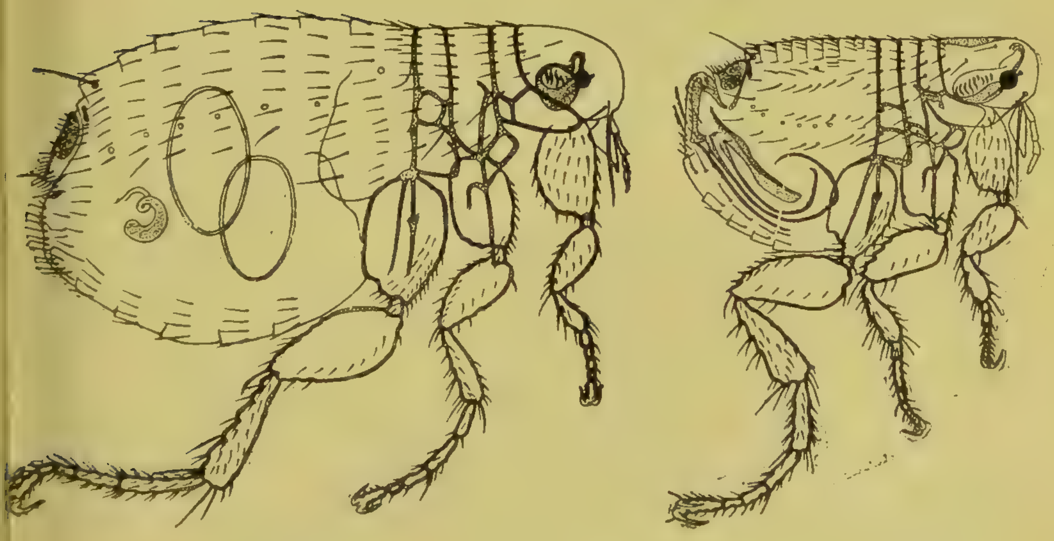
Blood of Plague-infected rat containing Plague bacilli.

relief of the irritation (see Report of Commission). Liston in his paper on "Plague Rats and Fleas" in 1905 made many valuable observations and experiments. But during the past 7 years the Plague Research Committee, working in Bombay, have made extensive observations regarding the relationship of rat Plague and human Plague, and the results of their work have supplied us with the data which place us in the position we are now in.



Stomach contents of flea showing Plague bacilli.

Pulex Cheopis.

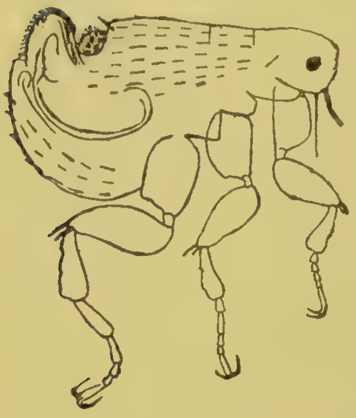


Female.

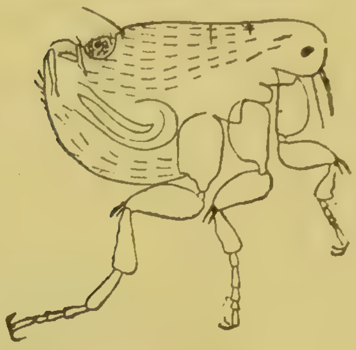
Male.

PULEX CHEOPIS.

♂ Pulex irritans



♂ Pulex cheopis



There are different kinds of fleas, chiefly distinguished by their size and colour, the shape of their claws, and the presence of bristles at particular parts.

Besides having structural differences, fleas vary in their preferences for different hosts. The rat flea generally remains on the rat, but when hungry may attack man or animal.

The flea seems to pass some time on the host, and the remainder in dust and dirt and sand. The eggs, about 12 in number, are laid in dust and dirt, and sometimes in the hair or fur of animals, and hatch out in about 50 hours or more. The young larva is a pearly white fourteen segmented grub (about 1·5 mm. in length) with a large brown head. The larvæ live about 7 days, and then spin cocoons and develope into chrysalids while in the dust. These chrysalids remain in the cocoon for about 8 days, so that about 17 days altogether are occupied in the growth and development of the flea. (Pearse on Insects and Diseases—*Calcutta Medical Journal.*)

Pulex cheopis (the Indian rat flea)—Small size, bright coloured. Loves the dark and is very sensitive to light. At first sight like the human flea. No bristles behind head, but bristles on posterior extremity of abdomen. Has elegant sickle-shaped claws.

Pulex irritans (Human flea)—Large size, bright coloured, eyes distinct. Found in dark and dirty habitations. No bristles behind head, but bristles on posterior extremity of abdomen. Claws large and scythe-like.

Pulex felis (Cat or Dog flea)—A small flea of dark colour. Not nocturnal in habits and frequently found in light places. Lives on dog, cat, rat, man and monkeys. Has combs behind head and teeth-like bristles around mouth.

Ceratophyllus fasciatus—Found on common European rat. Has combs behind head, but no bristles around mouth.

The flea then after having fed on an infected rat escapes from the dead body of the rat and searches for fresh food ; in its passage from the place where it is deposited by the dead rat, it comes in contact with human beings, and being hungry will attack man. Now it is not asserted that the bite of the flea alone is sufficient to convey the disease, although it is possible, but the flea having lived on a Plague-infected rat contains in its stomach a large number of Plague bacilli and the bacilli are deposited where the flea abides. It is thus possible for fleas to gain access into rooms, clothes and bedding of human beings, and then to bite and deject the bacilli, which gain entrance to the skin either by the pricking and irritation of the bite or by the breaking of the skin or wound. The habits of the people who sleep on the floor with scanty clothing, their uncovered feet and bodies constantly exposed to infected material make them ready victims to this method of attack.

It has not been, however, clearly shown that it is absolutely necessary for the flea to actually bite or live on the human being, but it is possible for the Plague bacilli in the dirt or the body of the rat or in the fæces of the flea to gain access to the human being.

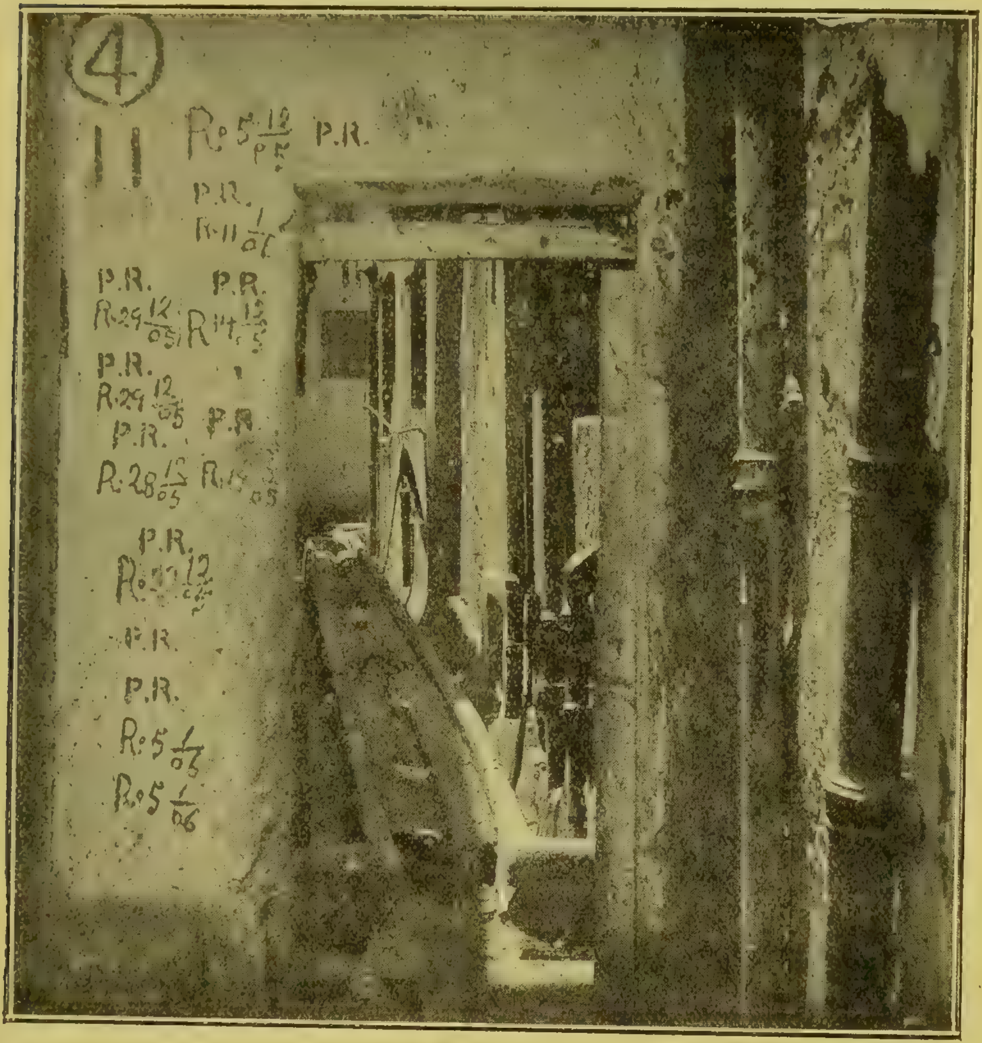
Rat fleas cannot travel far unless carried by a host. The rat is the common host of *P. cheopis*, but man occasionally carries these fleas on his person or clothing for long or short distances. Rat fleas cannot on their own legs travel great distances; twenty or thirty yards would constitute for them a long journey, but carried by a host they can cover some distance. *Pulex cheopis,* the rat flea, is most frequently carried by rats from place to place; but as rats usually confine themselves to comparatively small areas, and do not wander far from their holes, infection can only be spread in this way to a limited extent. At times, however, rats are carried in trains and in ships for long distances concealed among various articles of commerce, especially grain and rags. In this way rat fleas may be transported from place to place with the rats.

Another method by which transference may take place is by the carriage of these insects by man on his person or in his clothing for long or short journeys. This means of transporting rat fleas is most likely to occur when, rats having suddenly become scarce, the rat fleas seek man to feed upon. These conditions are most often found in a Plague infected house. People coming from such houses are liable, therefore, to harbour rat fleas on their person and some of these fleas may carry in their bodies the Plague germ. Thus it comes about that rat fleas are carried to healthy areas and, when introduced there, they leave man and seek the rats. If the rats are bitten by infected fleas, Plague may break out among these animals and later, in turn, man may become infected. In short, it may be stated that rats are usually responsible for the spread of Plague in an infected locality, but that man not infrequently carries infected fleas from an infected place to a healthy area at a distance.

The habit of using the street as a depository for filth and refuse affords a food supply for the rats.

A supply of food for the rats is to be found everywhere. Visit the gullies in the City and you can see, even while you wait for a few minutes, quantities of rice and other food material thrown out of the windows.

This is a photograph of a gully taken an hour or two after it had been swept out.



Observe the refuse accumulated in the central channel. The marks on the walls show that the gully has been badly infected by Plague. Each "P.R." with date indicates that on that particular date a rat was picked up here which was proved to be infected with Plague. There is here a record of at least ten Plague-infected rats picked up on different dates between the 5th of December 1905 and 5th of January 1906.

The keeping of Cows, Goats and Hens in Human Dwellings.

There is another habit of the people which favours the presence of rats among them, namely, that of keeping animals, particularly cows, goats and hens in their dwelling rooms. These animals during the day feed upon grain and all sorts of food material which becomes scattered about the street, affording food for rats.

IN A TOWN.

Among the poorer classes in India, and it should be remembered in this connection that in a city like Bombay seventy-six per cent. of the population live in single-rooms, it is the almost constant practice of the people to keep either hens or goats in their dwelling room. The hens furnish the inmates with eggs and meat, while the goats supply them with milk.

These conditions which associate men with rats are to be found throughout India.

Wherever you go in India the same story holds good. It is a country admirably adapted for the multiplication of rats. In the Punjab on inspection of a typical dwelling house, we shall find the stall or room for the cattle, and passing from it through the sleeping room of the family, we enter by another door, a room in which the grain supply for the year is kept, stored in large earthen vessels. These large grain bins are called *khoti* or *barola* according to their shape. In addition we may find a number of earthen pots or *ghurrahs* within the room. Spices, chillies and onions are stored in the *ghurrahs*. The rooms are generally very dark; windows are rarely found. Outside the door at one side of the house a ladder or staircase leads to the roof. Climbing on to the flat roof of the house, we note that this is used as a store for all sorts of materials.

PREVENTION OF PLAGUE.

Measures for the prevention of Plague are :—

1. Compulsory notification, and registration of the cause of death.
2. Rat killing, collection and examination.
3. Evacuation.
4. Disinfection.
5. Inoculation.
6. Improvement of insanitary areas.
7. Complete system of scavengering.
8. Free medical relief.
9. Circulation of knowledge by lectures, leaflets and diagrams.
10. Rat-proof dwellings.

Evacuation :—Of all the measures that are organised for combating Plague, evacuation of the infected area or houses as soon as the epidemic symptoms are notified, or even before that time, is the only measure the people voluntarily resort to. They have great faith in this measure.

In the early days of Plague perhaps they were averse to leave their homes for various reasons, as they were to every measure, but when they began to understand the cause of the spread of the disease, they eagerly resorted to camps.

The principle of evacuation is a sound one and when combined with rat destruction and examination of dead rats is of great utility in controlling the disease.

Previous to the anticipated outbreak, well-built temporary structures should be erected on suitable places not far removed from the area which will be affected. The hut should be built on a plinth in rows 20–30 feet apart, with proper bathing places and a good supply of water, with the floor and passages tarred, and receptacles for the deposit of refuse provided as well as latrines and urinals.

It is possible in some cases to vacate large areas before the outbreak begins but the people generally wait until rats begin to die.

Every dead rat should be examined and the result registered ; action should then be taken to vacate the building where the rats are found ; the whole building baited and trapped, pesterined and lime-washed, when it can be reoccupied 10–14 days later.

Rat campaigns should be organised during the off-season and continued all through the year.

In Bombay, this procedure is followed ; in some instances difficulty is experienced in moving people out, but with patience and perseverance, much can be done. The task is no light and easy one and requires tact and perseverance—as in all such measures for the control of infectious diseases in India.

It is argued by some that disinfection and evacuation are of little use in the prevention of Plague but the concurrence of opinion of those who have had actual experience is in favour of both. It is argued that it is too late to take action after Plague rats have been found but this argument is fallacious, as has often been proved in Bombay.

A dead rat is found in a room or passage, it is examined and found infected. It may be assumed that other rats are infected which may have not been picked up and not examined. It may also be assumed that each rat had one or more infected fleas on it before death and that the fleas have left the rat to find another temporary host. The passing of the flea from one rat to another means that it has to travel some distance and takes a certain amount of time in getting to the next host. In the meantime if the surroundings are properly pesterined, the fleas vacating one rat will have to pass through pesterine which they fail to do and die in the attempt.

To say it is too late to evacuate or disinfect after the death of a rat or human being is to forget what happens in every other infectious disease, where the cause is due to direct infection and not relying on the fleas. Take Small-pox, Tuberculosis, Diphtheria, a case or death occurring in a room. The room cannot be disinfected while the patient is alive but are no disinfecting precautions to be taken to prevent the spread of the disease after the death or removal of the case ?

Damage done by Rats.

Bombay—The Health Department are destroying over 500,000 rats in Bombay every year.

Deducting 10 per cent., *i.e.*, 50,000 for rats that do no harm, small rats, mice and musk rats, this leaves 4,50,000 *Mus rattus* and *Mus decumanus*, the black and brown rats. Half of these are females. Thus 2,25,000 female rats are destroyed annually. One female rat can have 6 litters of young every year and on an average either 8 or 10 in each litter and is thus capable of producing 48 rats per annum. Of these 48, 24 are females and at the age of 6 months each produces a litter of 8.

According to a *Fecundity Table* in "The Rat Problem" by Mr. Boelter, one pair of rats will produce 880 rats per annum.

FECUNDITY TABLE.

After Suschlag.

One pair of rats.

	Dec.	Feb.	Apl.	May	July	Aug.	Litters.
1 doe has a litter.	29	15	1	15	1	5 by	6 of 8=48
1st generation :							
1st litter: 4 does have litters.	Apl. 15 (a)	June 1 (a)	July 15 (a)	Sept. 1 (a)	... ...	4 by	4 of 8=128
2nd litter: 4 does (b) have litters.	June 1	July 15	Sept. 1		...	3 by	4 of 3=96
3rd litter: 4 does (c) have litters.	July 15 (c)	Sept. 1 (c)		...	...	2 by	4 of 8=64
4th litter: 4 does have litters.	Sept. 1 (d)		...	...	...	1 by	4 of 8=32
2nd generation :							
1st litter: 16 does (a) have litters.	Aug. 1	Sept. 15		...	...	2 by	16 of 8=256
2nd litter ... (a)	... Sept. 15	...		...	...	1 by	16 of 8=128
1st litter: 16 does (b) have litters.	...	...		...	...	1 by	16 of 8=128
						Total ...	880

The natural and infant mortality amongst these rats must be enormous ; otherwise, by killing 225,000 female rats per annum, 198,000,000 rats would be prevented coming into existence every year.

About 14,000 Plague infected rats are found in the City yearly.

The percentage of Plague infected rats to those found dead varies from 2 in November to 30 in March, or a mean of 12·3 per cent., or 3·0 per cent. to the total number destroyed annually.

Had these rats not been destroyed and assuming that the same ratios hold good, instead of 14,000 Plague infected rats being found in the City yearly, something appoximating 4,000,000 would be the number capable of spreading this disease as well as other diseases.

It is estimated by Mr. Boelter that there is a rat population in England and Wales of 40,000,000 rats, or 1 per head of the human population. Assuming that this ratio holds good in Bombay, before rat destruction began the rat population in Bombay would be 1,000,000. The natural mortality is estimated as 25 per cent. per annum and the mortality of rats accounted for by rat campaigns 25 per cent.

This does not represent the actual number destroyed, as many thousands are poisoned and their dead bodies washed out in the sewers and are never found; probably as many more are destroyed by rat campaigns, and the number is thus kept down, because in a confined and limited area the number could not go on increasing.

To give an idea of the damage done by rats in a city like Bombay, it is estimated by Mr. Boelter in his book. ("The Rat Problem"), that every rat will do one farthing's worth of damage every day.

In addition to the rats caught and collected, there must be about the same number dying of other causes, or roughly 1,000,000 per annum and this represents on the above basis about £400,000, or 60 lakhs of rupees per annum saved to the commerce of the City. But it means a great deal more than that, as, had these rats not been destroyed, after deducting deaths from natural causes, 25 per cent. of these could have increased to 200,000,000.

It might be argued that, by killing 500,000 rats annually in Bombay, the remaining become stronger and multiply faster. It has been compared to a war where the population of a country always become greater and stronger after a war; but in war the females are not killed, only males, while in rat war both are killed and very often in killing a female 10 others are killed and the war is always going on and the number thus kept down. An increase of males in wild multiparous animals tends to decrease the population if there be not a corresponding number of females.

In many of the grain godowns and shops in Bombay, in B Ward especially, rats are not allowed to be killed. On the contrary they are encouraged to live. Tins of water can be seen placed in the godown for the rats to drink. These rats can be seen in large numbers in the godown any day coming to drink.

It is estimated that in the grain godowns in the City there are rats doing a damage to the grain of at least Rs.50,00,000 (fifty lakhs) per annum.

The Diagnosis of Rat Plague.

Post-Mortem appearances :—

(1) *Rigor mortis.*—Well marked and prolonged, limbs project stiffly and the carcass has a *wooden rigidity.*

(2) Subcutaneous congestion and hæmorrhages. *Distinct reddish hue ;* on removing the skin, subcutaneous hæmorrhages seen commonly in the *submaxillary region* and *the flanks. Pink feet* in rats dead over one hour are quite characteristic and well marked in the fore-feet.

(3) *Buboes*—Characteristics :—

(*a*) *Primary situation*—in the order of their frequency.

(1) Neck. (2) Axilla. (3) Groin. (4) Pelvis.

75 per cent. in neck.

(*b*) Character of *Primary* Bubo—

Gland enlarged and congested and when cut across shows hæmorrhagic points.

Recognised by *enlarged hard masses* in the situation of the lymphatic glands, and there is infiltration and extravasation of blood in the vicinity.

Secondary buboes—

slightly enlarged and congested; absence of infiltration and hæmorrhages.

(4) *The Liver*—Larger than normal—*paler and pinkish* in advanced cases.

It pits on pressure and is easily lacerated. Lobules clearly demarcated and this, *combined with the yellowish* appearance of the parts affected, contrasting with the reddish colour of the congested areas, constitutes what is termed *mottling*. Small necrotic foci scattered over its surface; they are discrete and about the size of a pin's head and show as if it were dusted with pepper.

Granular or mottled appearance is very characteristic.

(5) *Spleen*—Larger and firmer. A necrotic patch if combined with even slight "mottling" of the liver is very suggestive of Plague.

(6) *The Pleuræ*—Pleural effusion is very characteristic. The effusion is quite clear and is often very abundant.

Remarks.—The presence of a typical bubo; after which in the order of their importance come the "granular" liver, subcutaneous hæmorrhages and pleural effusion.

If all these features are absent, then the rat is not Plague infected. A rat poisoned with the "rat exterminator" may show granular liver, but in this case the absence of all other signs of Plague and the *presence of acute inflammation of the stomach and intestines*, a condition *never seen in Plague*, serve to render the diagnosis easy.

A large subcutaneous hæmorrhage without other signs of Plague is due to injury.

Rats with eczematous or hairless patches should be discarded.

DESTRUCTION OF RATS:

Poisoning and Trapping.

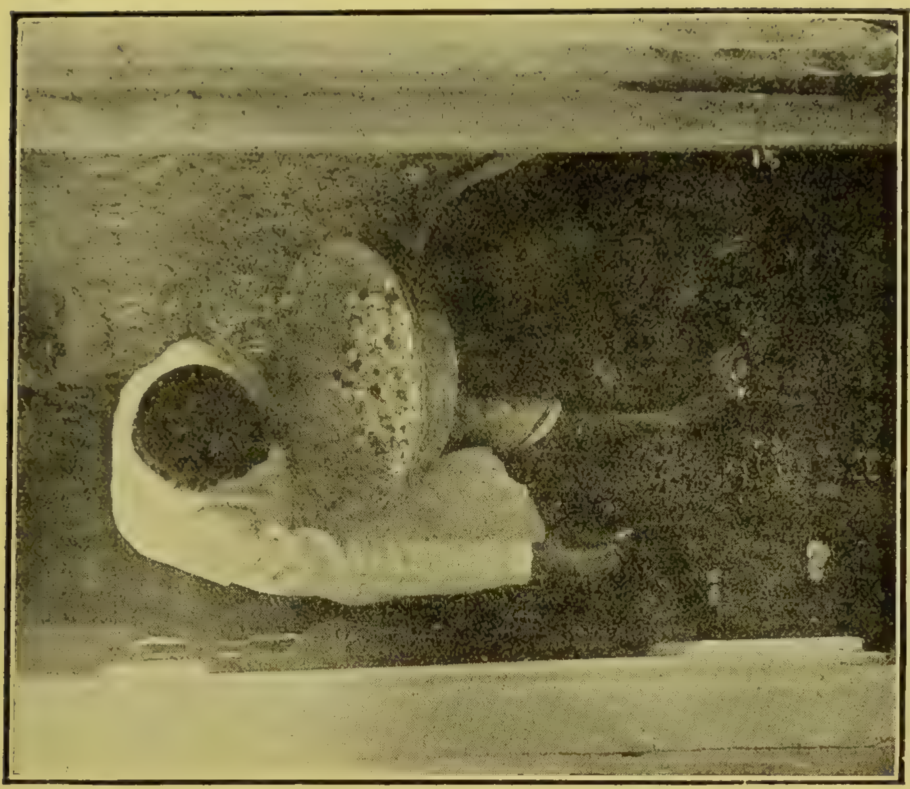
Poisoning.—The initial process in the destruction of rats in Bombay as a Plague preventive measure is that pieces of bread are used for making poison baits. Each loaf is cut into half inch cubes, which are smeared over with the poison which is prepared at the Municipal Laboratory, and dipped in powdered sugar and flour. The cubes are all counted before distribution.

Preparing Poison Baits.

The above picture illustrates the initial process in the destruction of rats in Bombay as a Plague preventive measure.

Another method.—Parched Indian corn is soaked in the poison and distributed in the same way. This has been found to be more economical and efficacious and easier of preparation.

The area to be treated is marked out in sections and circles, a certain number of men are told off, under a Mucadum and a Sub-Inspector. Each man has 200 to 300 baits



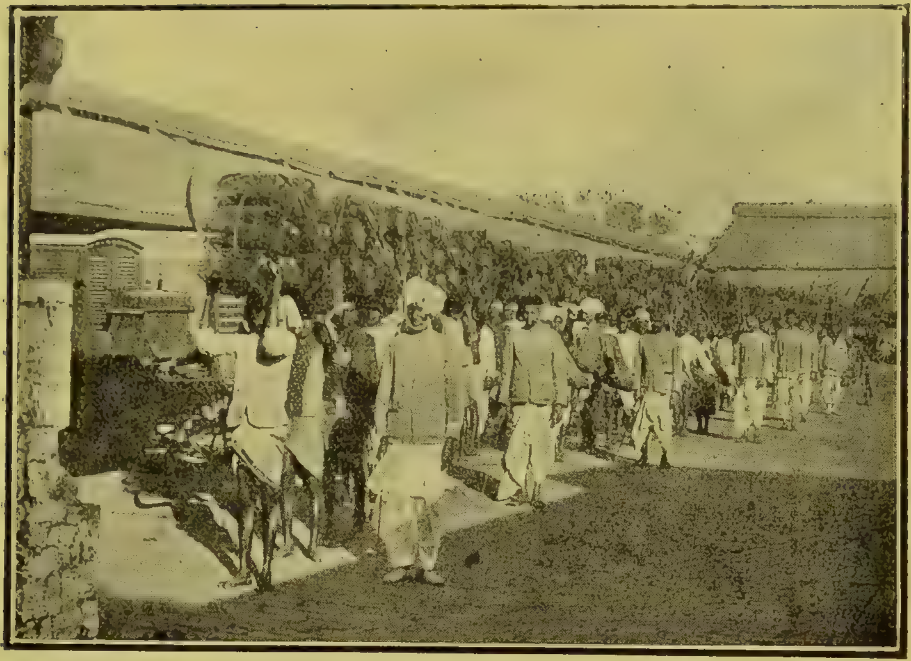
Shows the Poison Baits being laid in passages between the houses.

Shows the dead rats and baits not taken being collected next morning.

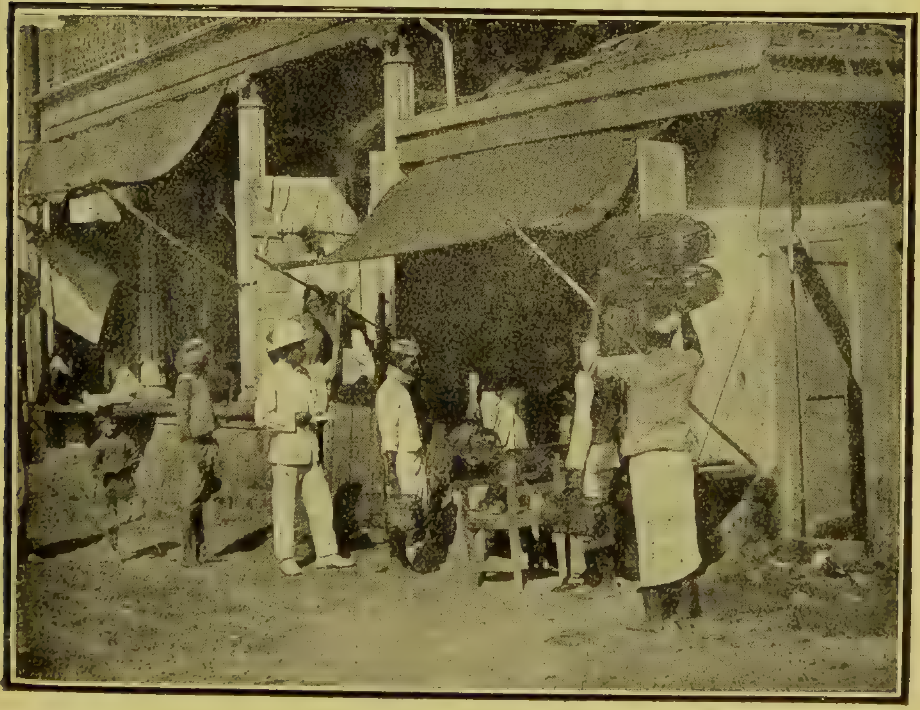
given to him which he lays between 5 and 7 P.M. Next morning between 6 and 8 he goes round his area and picks up the baits not used, counts and returns them to the Ward Stables. Dead rats are collected and the house, place and locality noted down on a card attached to the rat with the name of collector. Each rat thus collected is put in a tin box and labelled and sent to the Bombay Bacteriological Laboratory for examination. The result of the examination is sent to the office of the section in which the rat was found and if the rat was infected with Plague, action for disinfection of the place, house and passage where the rat was found is taken. In this way the phase of the rat epidemic or epizootic is known.

Trapping.—Pieces of bread, fish, cocoanut, &c., are used for baiting the traps. Traps are daily washed and disinfected before being distributed in the houses. There are 7,000 traps in use and between 1,800 to 2,000 rats are collected daily. Before the traps are sent out they are baited with pieces of cocoanut, bread, fish, &c., as stated above. In this manner traps are made ready to go out for a rat campaign. Each man carries 12 traps under the supervision of a Muccadum. These traps are distributed by the subordinates in houses and gullies in the City.

Shows the Traps being baited.



Shows the Traps being taken from one of the Health Department Stables to be distributed in the City.



Shows the distribution of Traps in houses in the City.

All results are daily sent to the Head Office and tabulated. The rise in the epizootic is noted, as it is always the precursor of the epidemic in men. The rat index is thus of immense value.

A map of each section is kept and the daily rat mortality and human mortality marked thereon with red and blue dots, with date of occurrence of each case.

There is a great deal of opposition on the part of certain castes of Indians, who refuse to allow rats to be killed or caught in their houses, and have notices put up "No rat-catchers allowed here."

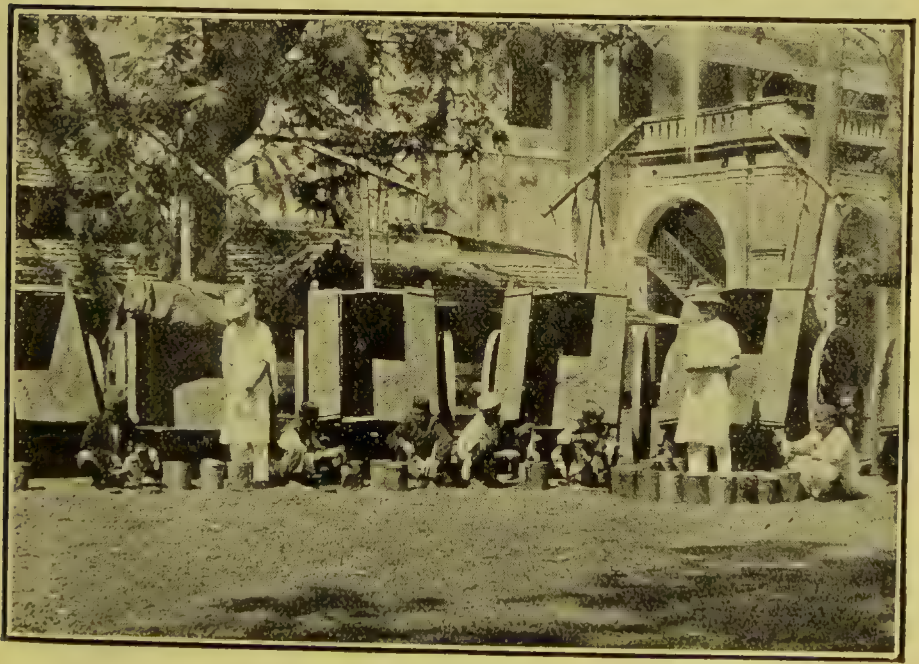
For each live rat half an anna and for each dead rat quarter of an anna is paid, so that a man catching 12 rats a day adds appreciably to his daily pay.

Live and dead rats are then brought into the Ward Stables, and registered and marked.

Shows the live and dead rats being brought in. All are registered and marked before being sent to the Laboratory at Parel for examination.

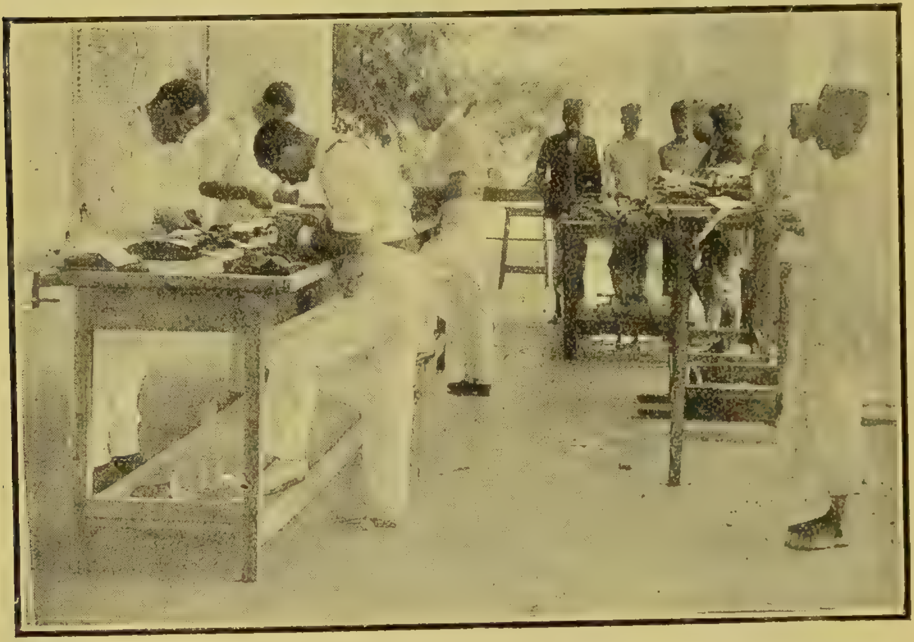
Traps and boxes containing live and dead rats are then placed in carts and sent to the Parel Laboratory for examination. On the arrival of the carts there, the box Nos. and the number of rats are checked by the Authorities there with the statement sent from the Health Department Stables, as each rat-catcher has to be paid (as mentioned above) for the rats he brings. If a rat is missed or lost on the way from the Stables to the Laboratory, a distance of 5 miles, the rat-catcher loses his fee. Empty traps and tins are then returned to the Wards concerned.

Shows a cart loaded with live and dead rats leaving for the Laboratory.



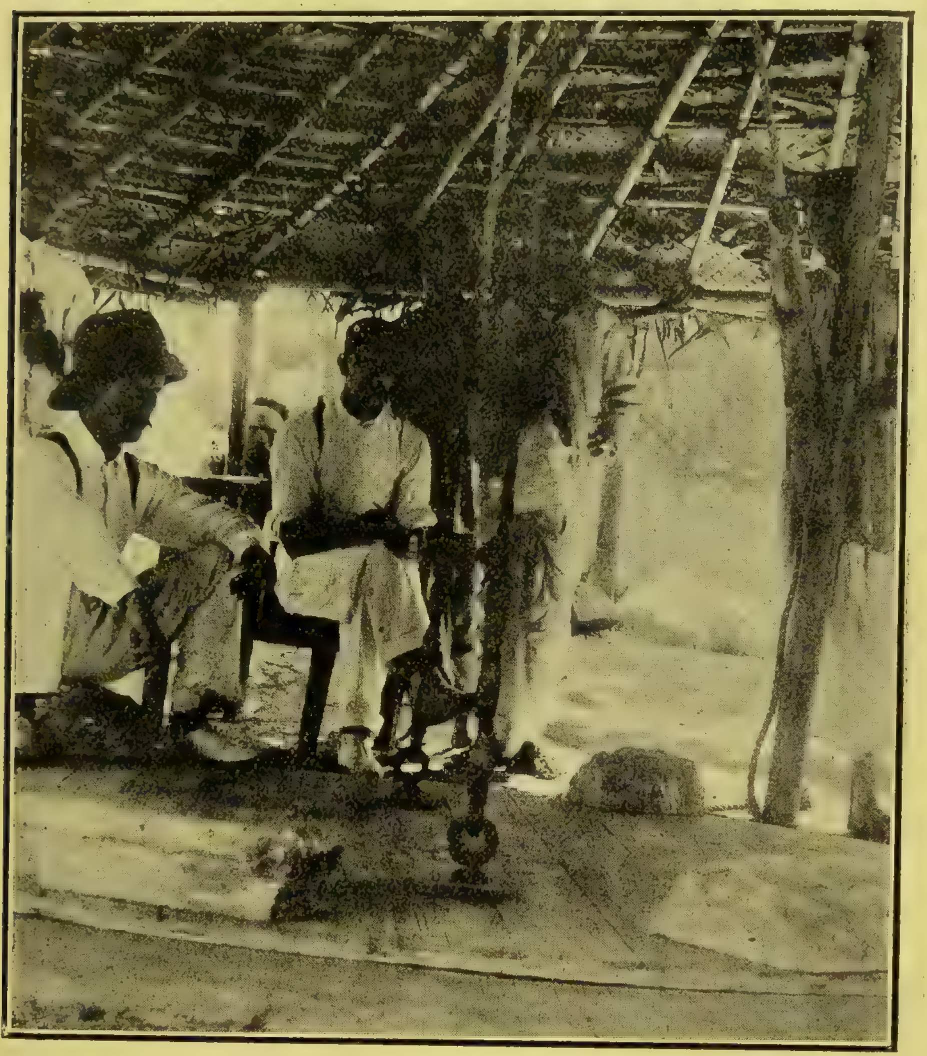
Shows the carts arriving at the Laboratory.

Checking the rats, with the statement sent from the Health Department tables as each rat-catcher has to be paid for the rats he brings.

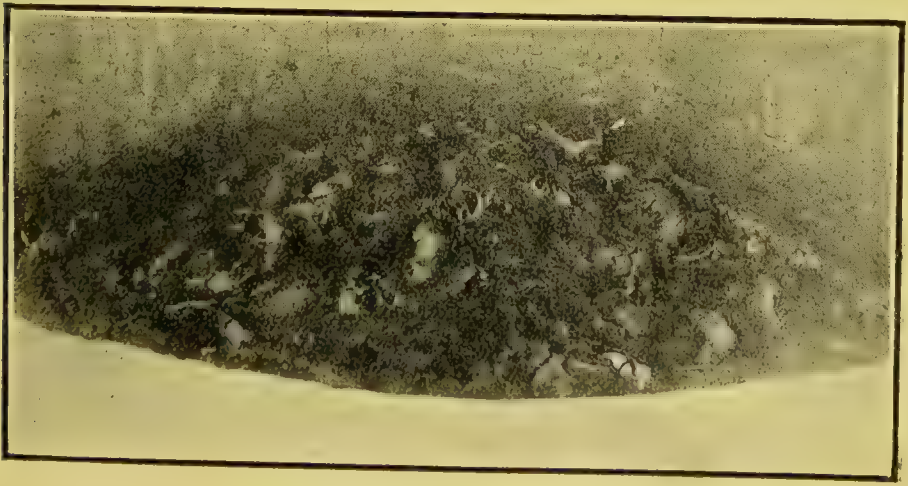


Examination of the dead rats at Parel Laboratory. A very unsavoury process but a very valuable index of the state of Plague.

Though the examination of the dead rats at Parel Laboratory is a very unsavoury process, it is a very valuable index of the state of Plague. The operators are British soldiers who are experts in this business. A *post-mortem* examination of rats is made, and it takes about 2 minutes to determine the presence of infection by the examination of the glands of the groin, neck, the organ, &c. From 500 to 700 dead rats are thus examined daily. The live and putrid rats are not examined.

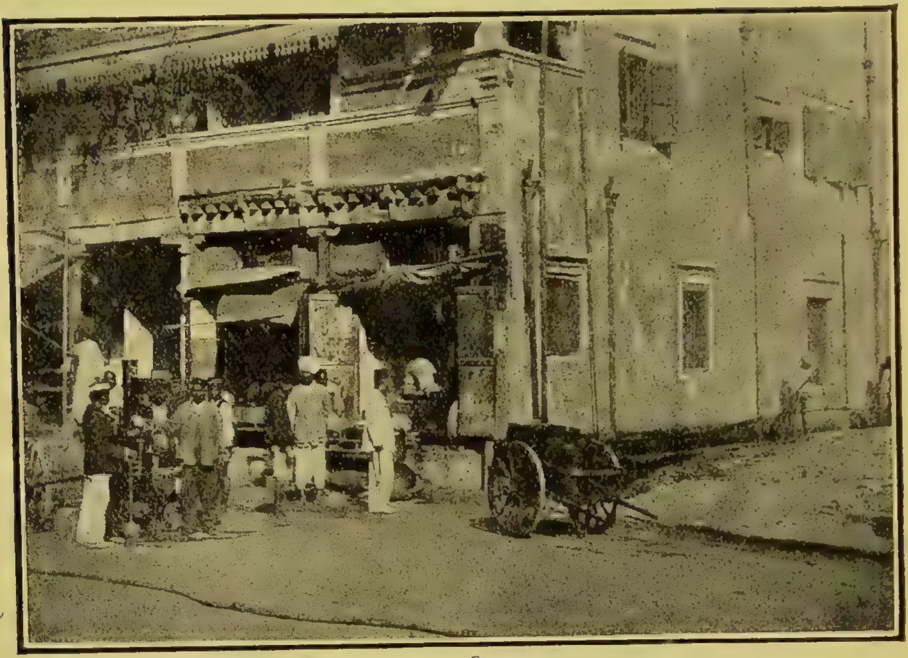


Shows the outside of the Lethal Chamber in which live rats are put.



Shows the inside of the Chamber after rats are killed. Here can be seen over 1,000 dead rats.

The house, where a dead infected rat is found, is flushed and disinfected with Pesterine (*vide* photograph which follows); the inmates are asked to move out, while the house is being disinfected, into a camp provided for them, and the locality treated again with poisoned baits and traps.



Shows the practical result in the City.

COST OF POISON.

The cost of the poison is annas 5 per tin, enough for 500 bread baits or 2,000 cereal baits.

Cost of preparing 3,000 *baits.*

	Rs.	a.	p.
30 *breads* of 1 lb. each at 17 per rupee	1	12	3
Sugar	0	4	0
Flour	0	2	0
Poison 2 tins at 0-5-3 each	0	10	6
(Ans. 4 for poison, 1 anna for tin and a quarter anna for labour).			
Labour for preparing baits	0	3	0
(One cooli for 4 hours at 6 annas a day of 8 hours).			
	2	15	9

	Rs.	a.	p.
Say about Rs. 3 per 3,000 baits ; therefore the cost for preparing 100 baits is about	0	1	7

These 100 baits are prepared from a bread of 1 lb. The bread is cut into 5 slices, each slice in its turn is divided into 20 pieces for baits.

The cost of *anna one and pies seven for* 100 *such baits* is arrived at as under :—

	Pies
Cost of a bread of 1 lb. at 17 per rupee	11·29
Do. flour	·8
Do. sugar	1·2
Do. poison	4·2
Do. labour	1.2
Total pies	19·09
equal to Re.	0 1 7

The time taken is 8 minutes for preparing 100 baits from a bread of 1 lb.

Disinfection for Plague.

In disinfecting against Plague infection, it was necessary to look for an insecticide.

The work done by the Plague Commission showed that the usual chemical disinfection had no effect on fleas.

In 1906, the Health Officer of Bombay, seeing the results obtained in France from the use of L'huile de Schiste in killing flies and their larvæ procured a small quantity and experimented on fleas in rat-infected houses. The result was so satisfactory that the Crude Fuel Oil is now used as the standard method of treating all rat-infected places. The name given to the substance was "Pesterine" and its use has become universal in India.

For further information, see the Health Officer's Report, 1906, and the Asiatic Petroleum Company's Pamphlet, "Liquid Fuel as a Disinfectant."

Petroleum Disinfection.

Disinfection with pesterine should be carried out thus: the articles required are:—(1) pesterine, (2) wooden or zinc buckets, (3) brushes, (4) brushes on long handles, (5) brooms, (6) a watering can.

The men who do the disinfection should wear long coats and protect their feet with shoes or *chuppals*.

Begin by sprinkling a little pesterine on the floor of the room to be disinfected. Then remove all the furniture, etc., out of the room. Any fleas dislodged during this process will be caught in the pesterine already sprinkled on the floor.

All clothing should be collected in sacks and sent to a sterilizer for disinfection with steam.

After the room has been emptied, begin by spreading pesterine with a long brush first over parts of the walls—up to 3 feet. Carefully go over all the nooks and cracks and ledges. Walls can be quickly done, if the brushes are used in a horizontal manner. Then sprinkle a little more pesterine on the floor, and with a broom spread it all over in an even manner. Generally it will be found that the quantity sprinkled at first, together with that splashed while doing the walls, will be quite sufficient for the floor.

Finally, pour a little quantity into every rat-hole seen on the floor.

Disinfection is now complete and the pesterine should be allowed to stand for twenty-four hours; the room is then fit for re-occupation.

Pesterine may also be used for disinfecting latrines and night-soil receptacles and accumulation of filth, and to kill flies, mosquitoes and other insects and their eggs and larvæ, and to prevent fermentation. Two pints or more of the oil to a superficial yard should be used, mixing it up with the contents of the receptacle.

Flies deposit their eggs in human and animal excreta and decomposing animal matter. Flies may convey germs of

Cholera, Typhoid and Tuberculosis and other infectious diseases.

Pesterine is useful in horse and cattle stables, and ground contaminated with urine and fæces ; collections of water should be treated by pouring the oil on the surface and allowing it to remain.

Crude petroleum oils answer the same purposes, but are more expensive.

How the Clothes of People from Plague-infected places may be disinfected by the Sun.

It is now well known that Plague is conveyed from rats to people by means of fleas. It has also been found out that people going from a Plague-infected place to another that is free from Plague may carry with them in their clothes, bedding or baggage the infected fleas of that place. On arrival at the end of the journey, the bedding is unrolled and the baggage unpacked, and the fleas being at liberty to hop out do so, and immediately go to the rats of the place to feast upon their blood. These fleas at the same time infect the rats with the Plague germs they have in their insides, and thus the rats get Plague and die, and soon the people of the village will begin to die of Plague also, for they will catch it from the rats. Now, as this is the way Plague comes to a village it is possible to prevent its arrival by killing all the fleas in the baggage, clothing and bedding of all new arrivals.

It has been discovered by experiment at the Parel Laboratory that it is quite easy to kill all fleas in clothings, bedding and baggage by spreading the things in the sun for an hour or so.

It is necessary to choose a smooth, sandy place where no grass or bushes grow and which is fully exposed to the sun, and there spread out the clothes in a single layer ; in a short time all the fleas will be dead. Then the clothes will be quite safe and the owner may be allowed to enter the village with safety to its inhabitants.

The rules which are given below should be carefully followed, however, so as to make quite sure that all fleas are killed.

The great thing to remember is that the surface must be quite smooth and that the sand is hot enough before the clothes are laid on it.

Rules.

1. A smooth flat piece of ground with no cracks in it should be chosen. It must not be near trees or houses, for it is necessary that the sun should shine on it all day.

2. The ground must have no stones or grass on it.

3. If the place is not a sandy one, it must be covered with a layer of sand 3 inches deep, and made quite smooth on top.

4. The sand must be very hot before the clothes are put on it. So it is necessary to wait till ten o'clock before spreading any clothes.

5. No clothes should be spread on the sand after 4 o'clock in the afternoon, for then the sand will not be hot enough.

6. The clothes should be spread evenly on the sand in a single layer.

7. The clothes should be left in the sun for one hour.

8. Thick and padded clothes, such as *resais* and quilted coats, must be turned over once or twice while exposed to the sun so that both sides may become well heated.

9. Clothes must not be placed within 3 feet of the edge of the prepared ground, otherwise some fleas might escape the heat of the sun and so infect the village.

10. Before the clothes are spread on the sand, it is necessary to see that the surface is quite smooth and that cows or other animals are not allowed to walk over it and make foot-prints on it.

INOCULATION.

Major Liston, C.I.E., I.M.S., Director of the Bombay Bacteriological Laboratory, where the Plague Vaccine is prepared, says in his pamphlet on "Plague Prevention" :—

"This means of acquiring temporary immunity to the disease has generally been called in India—Inoculation. It has the advantage of being a measure of personal prophylaxis, which can be carried out easily and cheaply, and it matters little who else does or does not co-operate in the measure. This is a great advantage in a country like India. The inoculated acquire a high degree of protection, and the mortality from the disease among them has been shown to be about one-sixth of that of the uninoculated under the same conditions.

"The following statistics are selected not because they demonstrate the best results obtained by inoculation, but because in each instance they have been very carefully examined; the records in every case having been accurately kept.

"A very virulent epidemic of Plague was raging in the village of Undhera in the Baroda State. The village was visited and a nominal roll of all the inhabitants then living in each household was made, and as nearly as possible one-half of the members of each household were inoculated. It was found that there were 950 persons then alive in the village, and of these 513 were there and then inoculated. No selection was made other than that required to make the inoculated and uninoculated groups as similar as possible as far as age, sex and physical fitness were concerned. Plague continued in the village for 42 days after the inoculations were performed. The disease occurred in the house occupied by 28 families. These families were composed of 71 inoculated and 64 not inoculated persons. The 71 inoculated had 8 attacks with 3 deaths, while the 64 not inoculated had 27 attacks with 26 deaths. We may infer that in this single village no less than 26 lives were saved by inoculation.

"In the Punjab a large number of people have been inoculated. Major Wilkinson, late Chief Plague Medical Officer, has given us the figures referring to villages in which more than 10 per cent. of the inhabitants were inoculated four months or less before Plague occurred in them. In these villages there were 186,797 inoculated as compared with 639,630 uninoculated persons. Among the inoculated there were 314 deaths from Plague. Among the uninoculated there were 29,723. From these figures it is easy to calculate that nearly 8,000 lives were saved in these villages by inoculation

" Quite as good, if not better, results have been obtained in Bombay City.

" In a *chawl* near Pilot Bunder inoculation was carried out two months before Plague broke out in it. 61 persons lived in this *chawl*, and of these 24 had been inoculated. Only one of the 24 was attacked by Plague and he recovered, while of the 37 uninoculated, 19 were attacked by the disease and 12 of them died. In this single building 12 lives were saved by inoculation.

" Dr. Turner and his staff inoculated a large number of the Municipal servants living in certain Municipal chawls, with the following results :—3,317 were inoculated, while only 838 remained uninoculated. Among the large number of inoculated there were 3 deaths from Plague, while among the small number of uninoculated there were 18. Sixty lives were saved by inoculation.

" In Karachi a similar saving of life was effected. 1,245 inoculated had 4 deaths while 60 uninoculated had 5. It is easy to calculate that 100 lives were saved by inoculation.

" Among the Police in Khandesh great saving of life was effected by inoculation. 1,508 inoculated policemen had 3 deaths from Plague, while of 230 uninoculated 4 died. 23 lives were saved.

" Railway Companies have had a like experience. The Southern Mahratta Railway Company had 1,260 of their hands inoculated in Hubli, and 760 living in the same places refused to be done. The former had 2 deaths among them, while the latter had 21. Inoculation in this case saved 33 lives.

" Millowners can confirm the advantages of inoculation. Mr. Bazonji Dadabhoy, Manager of the Empress Mills at Nagpur, found that 1,116 inoculated mill-hands had 6 deaths from Plague among them, while 2,663 uninoculated mill-hands had 179 deaths from Plague. Sixty-nine lives were saved by inoculation in this case.

" So much then for the value of the protection afforded by inoculation. Although inoculation cannot eradicate Plague from a country or district, nevertheless every case which is saved from the disease is so much gain; and, moreover, affords less opportunities for the spreading of infection by friends who would have come from other towns and villages to attend the funeral ceremonies.

"Inoculation, too, has the great advantage of instilling into those who undergo the operation that confidence which is so necessary to avert a panic. When the majority in a village are inoculated, the epidemic assumes such moderate proportions that it can be dealt with easily, nor is it difficult to adopt measures to prevent the spread of infection to adjoining areas."

SMALL-POX AND VACCINATION.

History.—The origin of Small-pox is involved in much obscurity. It is supposed to have its origin in the East; certain it is that this very loathsome and fatal disease has been known in India for a long time. It was a disease from which almost every person born had to suffer and from which a large number of persons died or were disfigured terribly.

Inoculation.—The experience of the disease had shown that a person was not seized with it twice, that in a large percentage of cases one attack was protective against future attacks. In this experience is to be found the origin of the inoculation of Small-pox, a method consisting in inoculating the variolous matter into a wound on the body of the person previously untouched by Small-pox and thus giving him immunity from an attack of the natural disease. Who invented this method of protective inoculation it is difficult to say. But the inoculated disease was found to be much milder than the natural disease and was therefore very willingly resorted to by the countries which suffered from Small-pox.

According to tradition, inoculation was a most ancient custom in India. It was practised by a particular tribe of Brahmins who, Mr. Holwell informs us, "were delegated from the different Colleges of Bindoobund, Beneras, etc., over all the provinces. These divided themselves into small batches and arranged their circuits in such manner as to arrive at their respective places sof destination some weeks before the usual return of the disease." The Brahmins operated at the door refusing to inoculate any who had not observed previously for a month the preparatory course of abstinence from fish, etc. Friction with a piece of dry cloth was made on the forearm or other part intended for inoculation ; slight scratches with a fine sharp instrument were then made but scarcely deep enough to draw blood ; on this was bandaged a moistened pledget of cotton saturated with matter from the inoculated pustules of the previous year. The pledget was allowed to remain for six hours, after which the bandage was removed and the pledget left to fail of itself. The inoculated person was frequently douched with cold water over the head and shoulders up to the time of eruptive fever and the douches were resumed on the appearance of the pustules.

But inoculation had its own drawbacks. The method was not as safe as one could have wished and proved fatal in some cases ; worse still, the inoculated disease was as infectious to the unprotected as the natural disease. It was, however, the milder of the two evils and continued to be practised in India till late.

Vaccination.—In 1798 Edward Jenner published his enquiry into the causes and effects of variolæ vaccinæ and proved that a person who had the Cow-pox either accidentally or intentionally was not susceptible to inoculation of Small-pox and consequently was safe from the natural disease. He proved that it was possible to propagate the Cow-pox by inoculation after the manner of Small-pox inoculation, first from cow to man and subsequently from one human subject to another.

Vaccination in Bombay.

The earliest record of vaccination available in Bombay pertains to the year 1849. But there is no doubt that vaccination was introduced into Bombay half a century earlier. History tells us that Jenner was very anxious about the introduction of vaccination in India. In 1799, about the end of the year, he sent copies of his works and a quantity of vaccine on board the "Queen," an East India man, but the vessel was unfortunately wrecked on the outward voyage and the object was frustrated. Jenner renewed his attempt; but the lymph was transmitted on lancet points or by means of threads soaked in the virus; but the length of the voyage and vicissitudes of climate for a time rendered futile all attempts to diffuse vaccination to the East. Eventually the genius of Jenner triumphed; for he secured the services of series of volunteers who were successively vaccinated during the voyage and Cow-pox was thus transmitted from arm-to-arm until it reached Ceylon and India. In the meantime a supply of lymph had entered India from another source through Bombay; for in the spring of 1799, Dr. Pearson sent to Dr. Decarro, a Genoese by birth, then settled in Vienna, a supply of lymph upon threads. Decarro vaccinated successfully with it and in turn sent some of his lymph to Thomas Bruce, Earl of Elgin, who was then British Ambassador at Constantinople. He with the courage of a Wortley Montague first vaccinated his own son and then transmitted some of the lymph to Bombay, where the practice spread. The new method was at first opposed by the inhabitants but their objection was in part overcome by a "pious fraud." Mr. Ellis of Madras composed a short Sanskrit poem on the subject of vaccination. It was inscribed on old paper to give it an air of antiquity. In the Bombay Presidency impetus to the work was given by the Honourable Mountstuart Elphinstone, who ruled at Bombay, 1819-1827. The province was divided into 4 divisions, a European Vaccinator being in charge of each division. Arm-to-arm vaccination was practised in Bombay till 1869, when it was replaced by animal vaccination.

The Bombay Vaccination Act of 1877 requires every Bombay-born child to be vaccinated within six months of its birth, and every outborn person under 14 years within three months of his arrival in Bombay. Bombay was the first City in India to make vaccination compulsory. The Registrar of Births sends a notice to the parent or guardian of the child directing his attention to the Vaccination Act, which requires the vaccination to be done within six months of birth, and mentioning the place and hour where vaccination is done free of charge on a certain day of the week. He also submits to the Superintendent of Vaccination, through the Executive Health Officer, the list of births registered by him.

Bombay is divided into six vaccination districts, each under a vaccinator. He is assisted by 3 or 4 karkuns under him whose chief duty is to find out the children for vaccination.

Each district has two public Vaccine Stations, where vaccination is done free of charge once a week. Every vaccinated child has to be brought at the same station next week for inspection by the Superintendent, or the Assistant Superintendent, when a certificate of successful vaccination is given. The date of vaccination of each Bombay-born child is put against its name in the Register and notices are served against the rest as soon as they reach the age of six months.

Calf Inoculation.

Calf inoculation was started in Bombay in 1869, and the lymph was cultivated from calf to calf. The stock of lymph was at times renewed from the English lymph supplied by the Secretary of State and at times by Retro-vaccination.

In Bombay cow-calves are used for lymph. But a buffalo calf or a horse or an ass may also be used for the cultivation of lymphs.

Race.—Many vaccine institutes give much importance to the race of cow-calf used. Calves are supplied by a contractor who brings them mostly from Ahmednagar District. This is a poor race and does not give much lymph.

Age.—The calves are easily manageable only when they are young; from 9 months to 18 months is a suitable age-limit. In some places older animals are used.

Veterinary Examination.—All calves are examined by a qualified Veterinary Graduate after admission to the Depôt; emaciated or diseased calves are rejected and returned to the contractor.

Tuberculin test.—Calves are tested for tubercle before their use for vaccination purposes.

Isolation and Feeding.—Every batch is isolated by itself for at least 15 days before it is allowed to mix with the old stock. The infectious diseases likely to be brought in the Depôt by the new calves are Foot and Mouth Disease (very common), Rinderpest, Paraplasmosis and Anthrax. Much attention has to be given to the feeding of these calves, as generally they are received in a poor condition. On an average, a calf gets enough quantity of good dry hay daily, in addition to half a pound of the mixture of the following articles :—A pounded mixture of equal parts of gram, *toor*, and oil-cake is mixed with an equal weight of cotton seed. Salt is mixed at the rate of one *tola* to one pound.

Calves which are well fed and without any high temperature are selected for the operation of vaccination and shaved. In this Depôt only the lower part of the abdomen from umbilicus and a portion of the inner side of thighs is shaved. In some institutions the whole of the abdomen and even the thorax are used. The shaved area is well washed with soap and water and coated with a mixture of glycerine and carbolic acid 5 per cent. in case the part is abraded by a razor. The calf is then stabled in a separate place till it is actually required for use.

Just before the operation the temperature of the calf is taken, and if the animal has a temperature below 102° it is selected for inoculation. The shaved part is again washed with soap and sterile water and the calf is then kept on a " tilting " table in such a way that the mouth of the calf would come on the right hand side of the operator. The part is again washed by the sterile water by the operator himself. The instruments and appliances to be used for inoculation are previously sterilized in the hot chamber.

Inoculation of the Calf.—The calf is inoculated either (*a*) direct from calf, or (*b*) from preserved glycerinated vaccine.

The lymph used for inoculation purposes is from 96 to 120 hours' well-developed vesicles. Typical well-developed vesicles should be selected ; this can be done with a little practice. The selected vesicle is then squeezed by the expression forceps, when the lymph oozes out in the form of fine pure droplets. Care should be taken to remove the blood that comes out first.

(*b*) In the latter method the tube is to be cut at both ends by a file and the contents taken on a scalpel point.

In both cases the lymph is taken on the point of a scalpel and then introduced into the skin by making parallel linear incisions by the scalpel. The incisions should be deep and care should be taken not to allow the calf to bleed too much, as this is likely to wash off the lymph used.

Calves are inoculated for two purposes, either for vaccinating the children direct (from calf to arm) or for scraping the growth and preserving the lymph in glycerine as is described hereafter. For the first purpose, the calf is inoculated—(1) by punctures, or (2) by incisions of about half to one inch long. The development of punctures is slower than that of incisions and the calf can, therefore, be conveniently utilised on the 5th and 6th day for vaccination. For the second purpose, the calf is inoculated by long continued incisions about 4 to 5 inches in length and one inch apart from each other.

In both the cases the lymph should be distributed evenly along the line. The calf is kept in the same position on the table for about 5 minutes after the operation is over.

After-care of the calf.—The calf is then tethered in a clean stable in such a way as to prevent any injury to the vaccinated part. Aprons are used to cover the inoculated area, but it will be better to arrange the stalls in such a way as to prevent the calf from licking the operated part. After 48 hours, the temperature of the calf is taken morning and evening and the operated area is inspected from day to day, marking the development of vesicles.

Preparation of glycerinated vaccine.—Nearly at the completion of 120 hours, most of the vesicles mature. This is the time for the collection of the lymph and the animal is again placed on the operation table in the same position as described above. The inoculated surface is thoroughly washed with neutral soap and sterilized water and gently rubbed over it by clean hands of the operator. The process is repeated till the part is completely clean. A towel soaked with water is then placed on the inoculated part for about ten minutes to moisten and soften the part. The growth is then collected by scraping with a sterilized spoon. The pulp obtained is received into a stoppered glass box and is then weighed. It is mixed with four times its weight of sterilized mixture of 50 per cent. pure glycerine in distilled water. The emulsion is prepared in mortar and pestle by hand rotation. In order to secure the thorough and complete pounding of the pulp with the above mixture of glycerine and water two-and-half hours are required. The first, second and third doses of the above mixture equal to the weight of pulp are added at the interval of about 40 minutes and the last dose of mixture is added at the interval of half an hour. The emulsion is then poured into a tube-filling machine (Baird and Tatlock's), worked with water pressure. The arrangement of the machine is very simple and every part of the machine can be easily separated and sterilized. The tubes are hermetically sealed at both ends on a gas flame, care being taken to prevent heating of the lymph. The tubes are then kept in an Ice Chamber at a temperature of 40° to 50° F.

Testing of lymph.—The contents of the tube are then examined bacteriologically by the Municipal Analyst after four weeks and tested repeatedly till found sterile.

The potency of the lymph is afterwards tested on a calf and, if the results are satisfactory, the lymph is issued to the vaccinators for use on children for primary and re-vaccination. The activity of the lymph depends upon the quality of lymph when collected and the temperature under which it is kept.

Small-pox, as it occurs in the present day, may be divided into (1) Small-pox in the unvaccinated, and (2) Small-pox modified by vaccination. In both cases after a person has contracted the disease, he may remain to all appearance quite well for eleven or twelve days; he then becomes feverish and sick, and complains of pain in the back for two or three days. Finally, the eruption comes out (usually first on the face), pimples which fill with clear lymph and then become pustules and form crusts. If the spots on the face run together, the disease is called confluent: if they remain separate on the face the disease is called discrete.

Thus, when a person has been exposed to infection, he should be quarantined for a clear fortnight. If he remains quite well, he may be regarded as safe. The *patient is infectious from the very first symptom till all the scabs are off.* However, a case is rarely notified until the eruption appears, and if then properly isolated the spread of the disease is generally prevented. It has been found that if Small-pox were modified by vaccination, a patient treated in hospital would be free from infection five weeks after the eruption began to appear; if the disease were not modified, a patient (provided he recovered) would not be free from infection until eight weeks after the eruption began to appear. As the particles, by means of which the disease is spread, are stored up in the crusts, these should be kept oiled from the time they begin to form.

Cases in which the disease is modified by good vaccination are often so mild that the whole eruption may not amount to a dozen spots. Such cases are particularly liable to escape attention. The head of the household may know nothing about them, and there is little likelihood of a doctor being called in. Yet disease communicated from such a patient, if the receiver be unvaccinated, may be as severe as possible.

How very severe Small-pox may be, those who have had long experience in connection with the disease can testify. There are two forms in particular that occur—the so-called "*black Small-pox,*" where the eruption becomes dark from innumerable small hæmorrhages, and the *variolæ sine variolis*, where the disease is so malignant that there is no eruption but the skin is thickened and somewhat livid.

When a case of Small-pox is notified and the Health Officer has satisfied himself that it is really Small-pox, there are four steps to be taken, and all as promptly as possible—

(1) The patient must be isolated.

(2) Vaccination (or re-vaccination) must be offered to and pressed on those in the same house as the patient and persons ascertained to have been recently in contact with him.

(3) The patient's wearing apparel, bedding, &c., must be efficiently disinfected or destroyed, and his room thoroughly cleaned out.

(4) The origin of the case must be investigated. No pains should be spared in searching out the source of infection, especially if the case notified be the first in an outbreak. If the investigation be carefully made, the officer undertaking it will ordinarily ascertain the source. He must not abandon the search too soon, and be content with the lame conclusion that the disease reached the district ærially.

The necessity of a Health Officer satisfying himself that a case notified as Small-pox is really Small-pox is obvious. Not only are cases of Chicken-pox frequently reported as Small-pox, but also cases of Eczema and other skin diseases. Indeed, in one instance a man suffering from secondary Syphilis only was sent to Birkenhead Hospital as a case of Small-pox.

The incubation period of Small-pox is 12 days but may vary from 9 to 15. Duration of infectiveness is from 3 to 4 weeks.

The contagion is most active and the infectivity greatest during the period of maturation and crusting of the pustules. The virus is contained in the mouth and throat secretions and the skin eruptions and may be conveyed through the air in the dried epithelial scales and pus cells from the crusted pocks for considerable distances.

Local Government Board Regulations (*England*).—A Small-pox Hospital should not be erected—

(1) on any site where it would have within a quarter of a mile of it as a centre either a hospital, whether

for infectious diseases or not, or a workhouse, or any similar establishment, or a population of 150 to 200 persons; and

(2) on any site where it would have within half a mile of it as a centre a population of 500 to 600 persons, whether in one or more institutions or in dwelling houses.

Cases in which there is any considerable collection of inhabitants just beyond the half mile zone should always call for special consideration.

Small-pox arises solely from infection from a previous case.

Vaccination depends largely upon the efficiency of the operation and the number and character of the resulting scars. The protective influence wears away with the lapse of time and re-vaccination at or before the age of puberty is necessary.

In London there is a 'conscience' clause. In Germany vaccination and re-vaccination are compulsory.

Glycerinated Calf Lymph.—The glycerine serves to preserve the lymph, without in anyway interfering with its activity, and it destroys extraneous organisms.

The calves are previously tested with Tuberculin.

In Paris the lymph is diluted with an equal bulk of glycerine. In Brussels twice the bulk of glycerine is added. In England 5 to 8 times its bulk of 40 or 50 per cent. pure glycerine is added.

If vaccination is performed, within 48 hours of the exposure to contagion, on a person who has already contracted Small-pox, vaccinia ensues and Small-pox is avoided. But if performed at a later date, Small-pox is contracted, modified if within 3 days, but unmodified if later.

Objection to Vaccination.—The Indian community as a whole does not object to vaccination. Their indolence and apathy, however, comes in the way of their getting children vaccinated early, unless the Vaccination Department compels it. This compulsion the Act allows to be applied. There are, however, a few prejudices connected with vaccination which it is worthwhile noting. Of these, the first is the religious aspect given to vaccination. The ceremony performed is the same which is gone through when a person gets the Small-pox. It consists in what is known as "naming" the disease, which is done when the vaccine vesicles appear. On this day a worship is commenced in a certain form with burning of incense, a swing is provided with a number of Nimb-leaf strings hanging above it and ladies of the house and neighbours and friends sit on the swing and sing in praise of God. This ceremony goes on for 9 days when the "Vibhuti" ceremony is performed. This consists in applying "Abir" to the pustules; the friends and relations of the family send presents of sweets and fruits to the child. From this day the disease is said to be on the decline, but the worship referred to above continues till the 21st day when the child is given a bath and taken to the temple of goddess Shitalá, where the worship of the goddess is performed with great pomp and *éclat*. On the same day, friends and relations are invited to dine at the place. This ceremony is either much curtailed or even omitted by the higher classes of the Hindu community, but is still followed in detail among Khatris, Kolis, etc. All this means expense and consequent delay in the vaccination of children. Second, a superstition generally noticed among Kolis is that no vaccination is allowed to be done in the locality where there are cases of Small-pox, as thereby goddess Shitalá is believed to be much enraged. Evidently, this must refer to the inoculation days when, probably, during an epidemic, persons undergoing inoculation got the disease in much severer form than usual.

Effect of Vaccination on Small-pox.

The effect of vaccination on Small-pox will be seen by the comparison of the figures of mortality from Small-pox before and after 1877, the year when vaccination was made compulsory. The number of epidemics in the latter period is worth comparing with the number of epidemics in the former.

Before the Compulsory Vaccination Act.

Year.	No. of deaths.	Year.	No. of deaths.	Year.	No. of deaths.	Year.	No. of deaths.
1850*	1,308	1857	346	1864*	1,707	1871*	919
1851	510	1858*	1,714	1865	567	1872*	1,854
1852*	1,003	1859	374	1866*	1,077	1873	714
1853	677	1860	166	1867*	1,055	1874	261
1854	232	1861*	1,627	1868*	1,123	1875	248
1855*	1,088	1862	163	1869*	1,725	1876*	3,174
1856	179	1863*	1,059	1870	556	1877*	958

After the Compulsory Vaccination Act.

Year.	No. of deaths.	Year.	No. of deaths.	Year.	No. of deaths.	Year.	No. of deaths.
1878	357	1887	108	1896	701	1905*	2,161
1879	479	1888	482	1897	57	1906	276
1880	207	1889	304	1898	55	1907	86
1881	35	1890	150	1899	440	1908*	1,026
1882	92	1891	108	1900*	3,018	1909	473
1883*	1,461	1892	541	1901	159	1910*	1,008
1884	112	1893	201	1902	288	1911	443
1885	55	1894	531	1903*	1,477	1912	979
1886	19	1895	270	1904	568		

* Epidemic year.

In spite of the efforts of the Health Department to get all the children vaccinated, and to protect the City from Small-pox, epidemics of the disease, though on a much smaller scale than before, occur and the causes of these epidemics are as follows :—

(1) A certain number of births escape registration, and possibly these children are not vaccinated.

(2) Vaccination does not give a life-long immunity and in some countries, well-advanced in sanitation, re-vaccination in later period of life is made compulsory. No such law exists in Bombay.

(3) Influx of unprotected persons from other parts of India where vaccination is not carried out with the required vigour, and the difficulty of finding out such persons when they arrive in Bombay.

(4) The Hajis, most of whom are unprotected, were found to be bringing the infection from Mecca ; but the steps taken now to vaccinate them before leaving for the Haj will relieve the Health Department from one source of anxiety at least.

TRYPANOSOMIASIS OF MAN *or* SLEEPING SICKNESS.

Sleeping Sickness is caused by the entrance into the blood and cerebro-spinal fluid of a special form of Trypanosome gambiense. Monkeys are susceptible to this form of the disease, and also dogs and cats ; but up to the present guinea-pigs, donkeys, goats and sheep have not been found to be so.

The Trypanosome gambiense is transmitted from the sick to the healthy by a species of tsetse fly, Glossina palpalis. The distribution of Sleeping Sickness and of Glossina palpalis correspond.

The Glossina palpalis is generally found near water and requires a cool, shady, not too dense, undergrowth to thrive in. The tsetse fly is not unlike the ordinary house fly, but on examination it will be found to differ very markedly. It has in front a long straight proboscis with which it sucks blood.

Fly Belts.—The fly occurs in well-marked tracts, the so-called " Fly Belts of Africa."

It lives exclusively on blood and feeds on any animal. Koch considers they are especially partial to crocodiles.

Incubation period—2 to 3 weeks.

Symptoms.—The bite of an infected Glossina is followed by local irritation and fever recurring at irregular intervals. The cervical glands are enlarged and tender; skin affections and local œdemas; the spleen and liver are enlarged.

The condition known as Sleeping Sickness is the terminal stage of Trypanosoma infection. The average duration of this stage is from 4 to 8 months.

Methods of Prevention.

As in the case of Malaria, there are two broad principles to be recollected in conducting operations for the prevention of diseases disseminated by the tsetse fly:—

(I) Operations directed against the fly.

(II) Operations directed against the parasite which the fly transmits.

Practical preventive measures are framed with the object of attack tinghe problem along both lines.

In regard to the prevention of the spread of Sleeping Sickness the above principles may be applied practically in the following directions:—

I.—Operations directed against the fly.

(1) *Destruction of the pupæ of the fly.*—(*a*) By clearing of undergrowth, particularly near towns, encampments, fords, &c., in fact, wherever human beings are brought together in numbers. The clearing is best effected by burning. The heat generated by the fire and the exposure of the area to the full effects of the sun's rays by removing the shady undergrowth render the district unsuitable for the fly by raising the temperature above the point favourable to the development of the nymphæ. So in time the fly will die out of these "cleared areas." The fly does not exist apparently in hot, dry countries, *e.g.*, Egypt and India, probably owing to the fact that the nymphæ cannot develope under conditions found in these countries

(*b*) *Destruction of the food-stuff of the fly.*—The fly, as has been seen, lives almost exclusively on blood; hence, if deprived of the source of food supply, a diminution in numbers, in the first instance and, ultimately, a complete eradication might be expected. If the views of Koch be correct the problem is further simplified; because he is of opinion that the crocodile is the chief source of supply of food for the tsetse fly, and he has accordingly recommended the wholesale destruction of these animals.

(2) *Destruction of the fly by other animals which will prey on it.*—This might possibly be a practical line of attack. Certain kinds of fish have been employed to destroy larvæ of mosquitoes. The cultivation of some plant might be found whose odour would be obnoxious to the fly.

II.—Operations directed against the parasite which the fly transmits.

It is obvious that if we can devise means for preventing the fly from becoming infected by the Trypanosoma gambiense, it will cease to be a disseminator of Sleeping Sickness. In the case of animals infected by trypanosomes, the problem is comparatively simple and consists in the slaughter of such animals as are found harbouring the parasite and in this way the disease is stamped out gradually. In the case of man, means have to be discovered by which it will be possible to completely destroy all the trypanosomes without damaging seriously the host. This problem has not yet been solved, but it is engaging the serious attention of a number of investigators.

Destruction of Trypanosomes in the vertebrate host by drugs.

(*a*) *Arsenic.*—This drug has been extensively used by various investigators from Livingstone onwards.

(*b*) *Atoxyl* is a combination of arsenic and an aniline preparation. It was first used in the treatment of Trypanosomiasis by the workers at the Liverpool School (Thomas and Breiul). It was afterwards extensively employed by Koch in Uganda, and, from results obtained, he formed a very favourable opinion of its action in destroying trypanosomes.

(*c*) *Antimony Compounds.*

(*d*) *Aniline Dyes.*

A great variety of these have been employed in the attempt to destroy trypanosomes in the living body by Ehrlich, Mesnil and others.

(*e*) *Arsenikphenylglycin.*—The whole subject of the treatment of Trypanosomiasis by drugs is being considered by a Committee of the Royal Society. The Report of this Committee will be looked forward to with much interest.

Preventive Measures.

I. Isolation Camps.—These camps are situated in selected "fly-free areas," and receive the more advanced cases of Sleeping Sickness from the "fly areas." Every case of Trypanosomiasis, which is removed from the fly area, removes one source of infection for the fly. In these camps the patients are maintained and treated with drugs which have proved efficacious.

II. Detection of all harbourers of the Trypanosome and prevention of their movement into "clean fly-areas."—As will be readily understood, this is one of the most important methods of checking the spread of Sleeping Sickness; but, in order to put it into practice, it is absolutely essential that we should have a practical and certain means of detecting the harbourers of the parasite, even in the initial stages of the malady. Fortunately, the exact recognition of early cases of Sleeping Sickness has now been rendered easy and certain by the method of gland puncture. The juice of the enlarged glands of cases of Sleeping Sickness, especially the posterior cervical, shows many actively motile trypanosomes. Some of the juice can be obtained readily by puncturing a superficial gland in the posterior triangle of the neck with a hypodermic needle. The fluid is examined under a low power, 150 to 200 diameters, when the actively motile trypanosomes can be readily detected. In practice the posterior cervical glands should be palpated, and, if found to be enlarged, the traveller should be further examined by gland puncture to determine the presence or absence of trypanosomes in the gland juice. If the trypanosomes are found to be present, the person should not be allowed to enter a tsetse fly belt.

A convalescent from the disease migrating to another country should be periodically examined and kept in a fly-proof ward until he is pronounced free from infection.

The Tsetse Fly.

The Glossinæ have very thick proboscis, and large wings having characteristic venation. The most striking peculiarity in the wing is the course of the fourth longitudinal vein, which bends abruptly upwards about the middle. The Glossinæ are never found in mountains; they are seldom seen above 3,000 ft.; they are rarely found in close cultivation. Their habitat is always in the neighbourhood of open water, along the banks of rivers. They are most numerous along the water's edge. The essential conditions of a tsetse station are—the presence of open water, a wooded district and a loose soil.

Reproduction.—The Glossinæ do not lay eggs, but the eggs hatch and the larvæ feed, develop and moult within the body of the parent, so that when extruded they have practically reached the pupa stage.

Habits.—Tsetse flies are voracious blood suckers. They bite almost exclusively during the day. Both males and females are blood suckers.

Regulations issued by the Government of Bombay.

If a case of Sleeping Sickness occurs on any vessel after she has entered dock or has been moored at a wharf, the master shall forthwith cause information thereof to be given to the Dock Master or Superintendent of the wharf, who shall communicate the information to the Health Officer of the Port (through the Port Officer) and to the Superintendent of Police, and shall be responsible that the sick person is isolated as far as possible, and that free communication with the wharf is stopped until the Health Officer has inspected the vessel.

The Health Officer shall remove to a place appointed for the purpose in a building, permanently and effectually protected from access to biting flies by means of fine wire gauze netting, every person found on board suffering from or suspected to be suffering from Sleeping Sickness, and every such person shall be detained for observation and treatment in the said hospital or place, or any other hospital or place to which the removal of such persons may be authorized by Government, and shall be isolated in such a manner as will prevent as far as possible the communication of the disease to other persons by the agency of biting flies, and shall continue to be so detained and isolated until a medical officer authorized in this behalf by Government certifies that he is not suffering from Sleeping Sickness or that having suffered from the disease he has been cured.

The Health Officer shall inform the Municipal Health Officer in every case in which a person suffering or suspected to be suffering from Sleeping Sickness is removed under his orders to a hospital, or other place within Municipal limits, and, in cases in which the disease has not been definitely diagnosed at the time of removal, shall also report to the Municipal Health Officer whether the diagnosis is confirmed or not.

All persons removed to hospital or kept under observation at any place shall obey and conform to the rules, regulations and orders for the time being in force at such hospital or place.

CEREBRO-SPINAL FEVER.

Cerebro-Spinal Fever is very common in some parts of India, especially Calcutta. An organism having a diplo-coccus form, and often called the meningo-coccus,is believed to be the specific organism. The diplo-coccus is said to be commonly present in the nasal discharge of sufferers. This discharge is the main channel of infection. Overcrowding and bad air appear to predispose to an attack. The diagnosis can be confirmed bacteriologically by a lumber puncture, below the end of the spinal cord.

ANTHRAX OR SPLENIC FEVER.

Anthrax, or Splenic Fever is an infective disease due to the presence of a comparatively large bacillus, which multiplies rapidly in the blood of its host, and may be easily cultivated outside the body. The bacillus cannot develop unless it obtains a free supply of oxygen, and spores are never developed in the bacillus that grows in the blood. However, where the bacilli make their way from the lungs into the mouth, or from the bowels, and are discharged, spores may be readily formed. Thus, an infected animal may infect whole herds or flocks and render the pasturage infective. A diseased animal, therefore, should be at once killed and either burnt or buried, 6 ft. or 7 ft. deep (a depth at which the temperature will be below 54 deg. Fah. and oxygen will not be obtainable). Dung from infected animals, or blood, may be disinfected with 5 per cent. of carbolic acid.

Sheep and oxen, which readily take Anthrax from eating infected materials, are but slightly susceptible when the bacillus is introduced into the tissue through a wound ; but rabbits, guinea-pigs, mice, &c., are rapidly susceptible when the disease is inoculated.

In man, Anthrax commonly affects butchers and those who attend on animals,the infectious material obtaining access to the body through a wound—often a very slight one. A man has a scratch, probably on his face, or one of his hands or arms, and in killing or attending to an infected animal, inoculates himself. In from one to three days irritation is noticed at the point of inoculation. A day later there is a very small blister (containing clear serum) in the centre of an inflamed area. Then the contents of the blister become brown, and other blisters form round it. Gradually a browny-black eschar has formed, indicating the beginning of an area of mortification. Before the nature of Anthrax was understood, this used to be called a malignant pustule ; if this be promptly and freely excised, and the wound well cauterised, the disease will be effectually cured. If this be not done, and the inflammation be allowed to proceed, a considerable area becomes affected, part of which mortifies, and probably, sooner or later, the bacilli find their way into the system, giving rise to general Anthrax, as indicated by symptoms one associates with " blood poisoning."

Wool-sorters' disease (so-called because it especially attacks persons employed in processes of sorting various wools and hairs in worsted manufactories) is Anthrax derived from infected wool and hair. The disease was long known under this name at Bradford, though not recognised as Anthrax ; and about 1863, when Van mohair*was introduced as a textile fabric, the cases became more numerous. The disease occurred in two forms : that characterised by the malignant pustule already referrred to, or by a minor pustule or boil, and that having no external lesion.

" Internal Anthrax " so called, which among wool-sorters appears to be more common and more fatal than the other form of the disease, has ordinarily a rather longer incubation period. After, say, from two to twelve days, chilliness, profuse perspiration, flushing of the face, and short ness of breath, &c., indicate the onset, and these symptoms are somewhat suddenly followed by stormy toxic manifestations characterising the fully developed disease, high fever delirium, cramps, purging, vomitting, &c., usually followed by the death of the patient in from two to five days. In cases not fatal at this time, improvement begins about the sixth day. Even after much improvement the patient may have a relapse, and succumb to secondary inflammatory processes, in which the lungs are specially apt to be involved. There are, however, cases of internal Anthrax in which the disease is very mild, the symptoms being headache, depression, nausea, restlessness, dimness of sight, constriction of the chest, and some cramps in the calves. Often, quite early in the disease, symptoms of various acute local congestions arise. The lungs are specially apt to be affected, and the physical signs of that condition with the occurrence of a copious frothy, blood-stained expectoration are noted. Pleurisy, too, sometimes comes on, an extraordinary amount of serum being rapidly effused into the pleuræ. The spleen is usually enlarged.

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* The fleece of the goat inhabiting the Van district in Asia Minor.

By what channels do the bacilli reach the system? In the case of butchers and attendants on cattle, infection appears to be usually *through a wound*, but, no doubt, occasionally through the alimentary tract. Wool-sorters handling dirty fleece, wool, or hair, work in air polluted with dust, and, if the animals from which the fleece comes have had Anthrax,—specifically infected dust. This dust may infect through a wound or the alimentary tract, or it may be inhaled and reach the system through the respiratory tract.

The *chief remedial measures* recommended for the *relief of wool-sorters* are to the following effect:—

(1) Bales of noxious wools or hair should, before being opened, be steeped in water for ten or twelve hours, and in case the bales do not freely admit water they should be opened so as to do so.

(2) After this the wool or hair should be placed in a sud of hard water (about 120 deg. Fah.) and washed, then passed through the rollers and sorted while still damp.

(3) The sorting-rooms should be well ventilated, the floors swept daily, the walls and ceilings thoroughly cleansed once a quarter, and the walls washed once a year with lime-wash mixed with carbolic acid.

(4) No wool, hair or other material should be kept in a sorting-room so as to interfere with the proper ventilation thereof.

(5) No meals should be taken in a sorting-room nor food kept there, and proper provision should be made for sorters to wash in or near the sorting-room.

The duties of the Local Authority as regards Anthrax are to disseminate information about it; to see that all cases in cattle or sheep are duly reported and dealt with so as to prevent the spread of the disease; to investigate all cases occurring in man, and to see that all preventive measures are enforced as required.

Men are infected during the process of skinning diseased animals.

Anthrax Order of the Board of Agriculture.

Dung and litter are to be burnt, or disinfected and buried.

Carcasses must be buried in lime with the skin on, at a suitable place at which animals will not have access, and at a depth of not less than 6 feet below the surface. Before a carcass is removed for burial, all the natural openings must be plugged with tow or other suitable material saturated with a disinfectant.

LEPROSY.

Definition.—Leprosy is a chronic infective granulomatous disease produced by a specific bacterium, and characterised by lesions of the skin, nerves and viscera eventuating in local anæsthesia, ulceration and a great variety of trophic lesions. After a long course it is almost always fatal. It is a disease of tropical and sub-tropical countries.

In British India, in 1891, there were said to be 105,000 lepers in a population of 210,000,000 : a ratio of about 5 in 10,000.

Leprosy is found in all varieties of climate and on all kinds of geological strata. Social conditions are an important factor in determining distribution ; its endemic prevalence appearing to be bound up in some way with uncleanly habits, squalor and poverty.

Bacillus Lepræ have been found in the nasal mucus of lepers. The initial lesion of the disease is a specific ulceration of the septum of the nose. The bacillus is also found in all leprous deposits and in the specific lesions of the liver, spleen, testes and lymphatic glands.

Prevention.

With few exceptions, the best authorities believe that Leprosy is propagated by contagion. A sure and the most effectual way of suppressing the disease is thorough isolation of existing lepers. Where possible, lepers should be segregated in isolated asylums which should be so conducted as to prove attractive. Lepers ought not to be allowed to beg in the streets, to keep shops, or to handle food and clothes intended for sale, to wander about the country as pedlars or mendicants, to hire themselves out as servants or prostitutes, or to frequent fairs in public places. All lepers with ulcers should be more scrupulously isolated, their discharges, clothes and dressings being systematically destroyed or disinfected.

Among other measures may be mentioned :—

Scrupulous and systematic attention to personal and domestic hygiene and cleanliness ; frequent bathing and free use of soap ; frequent change of underclothings ; good food, fresh air, light work and the avoidance of fatigue and of exposure to bad weather.

A Leper Act has already been passed by the Government of Bombay under which powers are given to the Police to segregate lepers in the Matunga Leper Asylum of Bombay after they are examined and certified by the Police Surgeon.

ERYSIPELAS.

Erysipelas is characterised by spreading inflammation of the skin (or mucous membrane) due to the presence of micro-organisms. After inception, no symptoms are manifested for three to five days. About the time the swelling and redness of the skin begin, there is fever and languor, often headache, shivering and vomitting. The locality generally attacked is some part of the head (the first patch being on the lip, cheek, scalp, etc.) and there is often some sore throat. The fever is remittent in character, but present to some extent till the inflammation ceases to spread. Occasionally the inflammation is very slight, but, not infrequently, continues to spread for ten days. Where it is spreading there is a raised red line, and in rear of this redness the swelling shades off to the part attacked earliest which has recovered. Thus while the disease is advancing in one part it is receding in another. The inflammation at a particular part lasts about five days. Sometimes the disease re-appears during convalescence.

Debilitated persons, puerperal patients, drunkards, and those suffering from wounds, are specially liable to attack, and often suffer severely and fatally. In bad cases there may be Typhoid symptoms and death from exhaustion, or head symptoms and death from coma, etc. The scarf skin is shed at the parts attacked, and the particles of shed skin carry the infection, as they do in Scarlatina. The contents of the blisters, which form and burst, must also be regarded as infectious.

In very young children the disease may commence at the vulva, and in infants the navel may be the first part attacked. Such cases seem specially likely to prove fatal.

Erysipelas is infectious from the beginning of the inflammation till desquamation is finished, and the parts affected are absolutely clean; commonly this period is a little more than a fortnight.

A person exposed to infection after a week's quarantine is safe.

Cases of Erysipelas certainly require isolation, and are well suited for hospital treatment, where accommodation is available. The infected room, clothing, etc., should be promptly disinfected. Infectious particles may be retained in clothes and carried short distances.

In Erysipelas, as in Scarlatina, special efforts may be needed for the protection of surgical and puerperal cases from risk of infection.

DENGUE FEVER.

Definition :—Dengue Fever is a specific febrile disease peculiar to warm climates and characterised by severe articular and muscular pains, and a well marked eruption.

The incubation period is 1 to 3, sometimes to 7 days. Some authorities suggest that the disease is conveyed by Culex fatigans and Stegomyia faciata.

Prevention.

Perfect isolation of the individual during an epidemic of Dengue may be secured so as to escape the disease.

All measures for the extermination of mosquitoes should be taken during an epidemic. Drains, gully traps, and all places where the larvæ breed should be thoroughly flushed and disinfected with pesterine, izal or carbolic acid.

MEASLES.

Measles.—The subject infected with Measles remains to all appearances quite well for ten days. Then comes the introductory fever and catarrh. The eyelids and the lining of the nose and throat are inflamed. The eyes water, there is a copious discharge from the nostrils, and commonly a cough. There may be vomitting, as in Small-pox, but the back-pain so characteristic of Small-pox is absent. Usually, four days after these symptoms begin the eruption appears. It at first consists of minute specks (Measles is derived from a German word *maser,* a speck), which can be barely felt as raised above the rest of the skin surface, and these run together in patches, more or less crescentic in shape. The eruption commences on the face, neck and arms, and takes two or three days to come out. By the time it has reached the legs it begins to decline on the face, getting browner as it fades. Wherever the eruption has been, the cuticle comes off like scurf. In Measles, as in Small-pox, a person exposed to infection should be quarantined for a clear fortnight, and if, at the expiration of that time, he manifests no symptoms of illness he may be considered safe. The patient may be regarded as *infectious from the appearance of the earliest symptom till three or four weeks after the appearance of the rash.* If care has been taken to cleanse the patient he is then safe. There seems to be little doubt that the patient is specially infectious during the primary or catarrhal stage.

Rarely a patient suffers from a Measles eruption without any catarrhal symptoms, and sometimes patients exposed to infection manifest the febrile and catarrhal symptoms without there being any eruption. The first is a light form of Measles, the second often a severe form. The disease described as *putrid* Measles (marked by extreme debility, Diarrhœa and frequent gangrene), is extremely rare. Measles is not ordinarily required to be notified. It is not spread by milk or drinking water, nor is its incidence influenced by sewer gas, and no form of inoculation will protect a child. Owing to the special infectiousness of Measles for three or four days before the appearance of the eruption, and consequently before the malady is recognised, brothers and sisters and school-mates susceptible have probably been infected before the patient can be picked out and isolated.

The infectiousness of Measles does not appear to last for a long time, as does that of Scarlatina. However, little portions of infective matter discharged from the patient may lodge on the clothes of nurses, etc., and convey infection to short distances.

The Health Officer, in presence of an epidemic of Measles, may often find it expedient to use such powers as he possesses for closing schools. Children from infected families are commonly kept from school as soon as a case is reported. Clothing, etc., known to be infected should be disinfected, and the rooms occupied by patients well cleaned.

Measles is seldom a fatal disease in families comfortably off, but among the poor is very fatal, the main difference being that well-to-do people understand the importance of keeping the patient warm, and the poor do not.

Rubeola, or Rubella, better known as *German Measles,* or Epidemic Rose Rash, remains latent for about thirteen days, then there is a day or two of malaise or feverishness, and finally the rose rash, which more nearly resembles Scarlatina than Measles. A person exposed to infection should be quarantined for sixteen or seventeen days, and if at the end of that time he is quite well he may be regarded as safe. Rubeola resembles Measles in its exceptional infectiousness during the very earliest stage, and before the disease can be diagnosed. The patient ceases to be infectious after the rash has faded, and all branny skin is washed off, say, a fortnight after the rash began to appear.

The infectiousness of Rubeola has probably even less lasting power than that of Measles, but here also portions of infected matter may be carried on clothes to short distances.

Children from infected families should certainly be kept from school. Infected clothing should be disinfected, and the rooms occupied by patients properly cleaned.

Precautions against Measles.

1. Measles is a very fatal disease amongst infants.

2. It is very highly infectious especially in the early stage for several days before the rash appears. The early signs of the disease are coughing, sneezing, and redness of the eyes, with some degree of illness. When Measles has occurred in a school, coughing alone should be suspected.

3. A child at school with such marks of illness should be at once sent home, and the teachers, particularly in the Infant Department, should be on the look-out for the first signs of illness if Measles has made its appearance in the school or neighbourhood. The occurrence in a school of any catarrhal illness in a child, if Measles has made its appearance in the school, should be considered sufficient reason for sending the child home till the nature of the illness has become plain.

4. A child suffering from Measles should not be allowed to return to school until four weeks have passed after the appearance of the eruption.

5. Any one attacked with Measles should, if possible, be placed in a separate room upstairs, and the windows opened sufficiently to admit fresh air without allowing the room to get cold. The bed should be placed in that portion of the room in which there is least draught.

6. In view of the high percentage of mortality from the disease, parents are advised in every instance to seek medical advice.

7. The children at home not attacked must not go to school or other place of meeting for three weeks after the appearance of the eruption in the first child and, if subsequent cases occur, not until three weeks after the appearance of the eruption in the last child attacked.

8. Where a case of Measles has occurred in a house, a careful out-look should be kept on the other children, so that on the first appearance of the eruption of illness they may be kept at home and properly treated.

9. When a child at any house is suffering from Measles, no neighbour's child or neighbour accompanied by a child must be admitted, nor should the child ill with Measles be allowed to play with other children for a month after the appearance of the rash.

10. *Disinfection.*—Before the child attacked returns to school the following measures should be carried out. All articles of clothing worn by the sick child and the bedding and hangings of the sick-room should be washed and put out to air for some days. All washable articles of furniture in the room should be washed. The walls of the room should be limewashed. The floor should be thoroughly scrubbed and disinfected. The windows should be left open for several days and the window curtains removed so as to admit as much light as possible. The skin of the child who has been ill should be thoroughly cleansed by several washings with soap and warm water.

WHOOPING COUGH.

The onset of Whooping Cough is in many cases so insidious that it is difficult to say for how long it is entirely latent. It is probable that the latency does not ordinarily exceed four or five days ; then follows the catarrhal stage, lasting from three days to a week (occasionally a fortnight), and finally the paroxysmal cough and whoop. The cough consists of a number of expiratory motions in rapid succession, followed by a long inspiration, the air making a whooping noise as it passes through the partly closed rima glottidis, and this may be repeated two or three times during a paroxysm till mucus is forced up, or the child vomits. During the intermissions, if the disease is uncomplicated, the patient (usually a child) appears quite well. The violence of the paroxysm appears to depend on the difficulty of getting up the expectoration. The frequency of the paroxysms varies much in different cases and a different times. The duration of the disease is from about three weeks to three months. Relapses are not uncommon, and these may occur more than once.

Whooping Cough may be complicated with Bronchitis or Emphysema, or trouble from determination of blood to the head, and not unfrequently small ulcers appear under the tongue.

As the disease is infectious from the beginning of the catarrh (when probably Whooping Cough is not suspected) till mucus ceases to be coughed up, it is not surprising that it spreads rapidly, and is the most fatal of all diseases of children under five years of age.

A person exposed to infection, and manifesting no symptom of catarrh for a clear week is probably safe. In some districts in Europe Whooping Cough is required to be notified. However, notification is not of much service in respect of a disease which is infectious for days before it can be recognised.

Of course, children from infected houses should be kept from school; and in the presence of a severe outbreak it may be expedient to close the local schools.

Precautions against Whooping Cough.

1. Whooping Cough is a fatal disease amongst infants.

2. It is highly infectious, and when fully developed, is characterised by the well-known crowing sound. At the commencement of the disease, there may be nothing to indicate that it is coming on, except some degree of feverish cold, taken along with the fact that it has been preceded by Whooping Cough in other children. Sometimes frequency of cough announces its approach.

3. A child at school, in whom there is reason to believe that Whooping Cough is showing itself, or who has the disease well-marked should be at once sent home, and the teachers should be on the outlook for fresh cases. Any illness in the Infant Department following on the occurrence of Whooping Cough should be viewed with suspicion and the child sent home.

4. In looking for the occurrence of Whooping Cough among children under their charge, teachers should particularly observe that the disease may be ushered in by no observable symptoms, except perhaps coughing, and that any appearance of illness should be considered sufficient ground for sending a child home for a few days once the disease has made its appearance in the school.

5. A child attacked by Whooping Cough should, if possible, be isolated in a room upstairs, and the window opened sufficiently to admit fresh air without allowing the room to get cold.

6. The other children in the house should not go to school or other place of meeting, such as places of public worship or amusements, until three weeks have elapsed since the commencement of whooping.

7. When one child in a household has been attacked with Whooping Cough, the others should be watched, and any appearance of illness, especially with coughing, should be regarded as probably indicating Whooping Cough, and the child treated in the same manner as the one first attacked.

8. When a child at any house is suffering from Whooping Cough, no child or neighbour accompanied by a child must be admitted into the house; nor should the child with Whooping Cough be allowed to return to school or play with other children until the " whoops " have ceased to be observed.

9. The matter coughed or spat up by the sick child must be regarded as infectious, and should be received into pieces of rag which should be at once burnt. Discharges from the nostrils should be treated in the same manner.

10. In all cases of Whooping Cough, medical advice should be obtained until the child is out of danger.

11. *Disinfection.*—Before the child attacked returns to school, the following measures should be carried out. All articles of clothing worn by the sick child and the bedding and hangings of the sick-room should be washed and put out to air for some days. All washable articles of furni-

ture in the room should be washed. The walls of the room should be limewashed. The floor should be thoroughly scrubbed. The windows should be left open for several days and the window curtains removed so as to admit as much light as possible.

DIPHTHERIA.

Diphtheria, like Scarlatina, remains after its inception latent for two or three days. Like Scarlatina, also, it is a disease mainly affecting children at school-age (three to twelve years), and occasionally so mild that no serious disease is suspected, and the patient never comes under medical treatment. The initial case in an epidemic is thus often an unsuspected case. The first symptom attracting attention is commonly a sore throat, and, sometimes with this or before it is patchy, red rash about the neck and chest. Next a false membrane forms, extends and thickens and in course of time is shed. However, Diphtheritic membrane need not be in the throat—it may be in the windpipe or nostrils, or the membrane is not peculiar to Diphtheria even when it is in the throat. The difference between Diphtheria and some other diseases which resemble it (and which Bretonneau himself would doubtless have called Diphtheria), according to the modern view, is that Diphtheria is the disease due to infection by the bacillus of Klebs and Loeffler. The bacillus starts the disease, and the fever and other symptoms following are mainly the result of absorption of the chemical poison produced by the living bacillus. After the membrane has been shed, or before, an attack of Diphtheritic Paralysis is not infrequent. Indeed, Paralysis may follow in cases where Diphtheria was so mild as to be unrecognised.

Diphtheria is infectious from the inception of the disease till the throat is quite healthy. In cases sent to hospital or carefully treated, this time will not ordinarily exceed five weeks.

A person exposed to infection, who remains well after a week's quarantine, may be considered safe.

Diphtheria is not usually notified early, but prompt isolation will often prevent the spread. Isolation hospitals are particularly useful for cases of Diphtheria, as the disease often occurs in insanitary dwellings, from which it is of the first importance to remove the patient.

The house where a case occurs should be examined for defects, and, if discovered, these should be remedied. The disease seems to favour damp houses. The room, clothing, bedding, etc., should be disinfected, and the children from infected houses should be kept from school.

Schools may be closed with a view of checking the spread of Diphtheria when nothing worse than what appears to be sore throat is prevalent among the scholars ; and children suffering from sore-throat, however mild, should be kept from school. The disgusting way in which slates are often cleaned, the transferring of sweets from mouth to mouth, and the use of drinking cups common to many, are some of the many means by which Diphtheria may be spread at schools.

In investigating Diphtheria, it is often easy to trace the disease from case to case by means of personal intercourse, whilst it is usually most difficult to offer a reasonable explanation of the first case. The initial case or cases, may have come from a specifically infected cesspit, ditch-drain, etc., from the drinking water polluted thereby or otherwise, and even from cats, domestic fowls, or pigeons. As regards milk, it seems to be able to initiate the disease and may certainly spread it. When the bacillus is once introduced into milk, it readily multiplies even at ordinary temperatures. There is ground for believing that occasionally the cow, through being diseased, yields infective milk.

Persons who have just had or are recovering from Scarlatina or Measles, are specially liable to take Diphtheria, and so apparently are women who have been recently delivered.

The infection of Diphtheria, like that of Scarlatina can be retained in clothes, etc., for a long time—many months.

The Diphtheritic contagion is given off from the body in the secretions from the mouth, nose and throat, and clings to infected articles of clothing and bedding.

Epidemic prevalences of the disease commonly commence in September, reach their highest point during October and November, and then subside slowly during the following two months.

Incubation period is under 4 days' duration. An antitoxic serum is largely used for conferring immunity upon animals and also for arresting the disease after it has commenced in the human subject.

SCARLATINA.

Scarlatina after its inception commonly remains latent for two or three days, when the patient is feverish for a day or two and complains of headache, slight sore throat and stiffness of the neck. These symptoms are followed by eruptions beginning in minute points but these become so numerous as to produce a general redness of the surface. The eruption is brighter in colour and less elevated than in the case of Measles. The rash begins on the face and neck and spreads over the whole body, and may be expected to last three or four days before fading. Probably, about a week after the first symptom the peeling begins, and a very slow process this is, lasting many weeks. The skin is usually shed in fine scales from the head and body, and in flakes from the extremities. With the early symptoms, a white fur gathers on the tongue, and through this appear the red swelled papillæ, then the white fur clears away, and the whole tongue looks exceptionally red and rough. The throat gets very red, and the tonsils swell and redden. Then a whitish exudation may appear, and ulceration or even sloughing. The degree of severity and danger differs much in different cases and in different epidemics. In so-called simple Scarlatina the florid rash may be accompanied by little or no sore throat; and in malignant Scarlatina the rash is usually late and imperfect or absent, while the throat symptoms or head symptoms are so severe as to cause death.

Scarlatina is infectious from the earliest symptom till desquamation is complete and the patient absolutely clean. This ordinarily takes not less than five or six weeks, and occasionally nine or ten.

A person exposed to infection should be quarantined for a week, and if he then shows no signs of illness he may be considered safe. Though a case of Scarlatina is not usually notified till the rash has begun to appear, the disease is so slightly infectious at first, that prompt isolation will generally prevent the spread of the disease. Isolation hospitals are probably of more use for isolating cases of Scarlatina than for any other disease. The room, clothing, bedding, etc., should then be promptly disinfected; and children from infected houses should be kept from school till safe.

In the presence of an epidemic it may be well to take steps for closing the local schools; but when a good hospital is provided this will not be often needed.

Return cases (cases re-appearing in households shortly after the return of a patient from hospital) are not always easy to account for, but they would be very rare if great care were always taken to keep patients in hospital till all peeling had finished, and any discharge they might have from ears or nose had ceased. Infectious particles may be retained in clothes, etc., for months.

That a person suffering from a wound or injury, or a woman recently delivered, is specially liable to become infected with Scarlatina is a well-established fact. It is reasonable, therefore, that special efforts should be made for the protection of surgical and puerperal cases from the risk of Scarlatina infection.

In investigating an outbreak of Scarlatina, the frequency with which the disease has been *spread by milk* must be borne in mind. The milkers, collectors, or distributors of the milk may have contaminated it, the vessel in which the milk is delivered may have been recently in an infected house; and there may be some ground for believing that occasionally the cow has an allied disease and yields infective milk,

CHICKEN-POX.

Chicken-pox patients (like Small-pox patients), after having caught the disease, remain to all appearances quite well for eleven or twelve days—one or two days more or less—and then are slightly feverish and indisposed for two or three days. The premonitory fever and indisposition may be absent. About the fourteenth day appears the eruption usually commencing on the shoulders, neck and breast, and often spreading on the face. The eruption is one of transparent vesicles, like little blisters produced by boiling water. The blisters come out in crops, the earlier ones shrivelling while the new ones are forming. Blisters which do not shrivel quickly get slightly opaque. A person exposed to infection, remaining well for a fortnight, is ordinarily safe. The patient is infectious from the first symptom till all the scabs are off. Chicken-pox is commonly a disease of children, but adults are not infrequently seen suffering therefrom.

A district in which infectious diseases are compulsorily notifiable will do well to add Chicken-pox to the list of diseases required to be notified. If this be not done, sooner or later, some mild case of Small-pox may escape notice.

The children of a family in which one is suffering from Chicken-pox should be kept from school, for the infectious particles may be conveyed in clothing. The patient's room should be cleaned, and his clothes, etc., disinfected.

An attack of Chicken-pox is occasionally very severe. It is not prevented or modified in any way by vaccination.

INFLUENZA.

Influenza is latent ordinarily for three or four days, a day more or less being not uncommon. Occasionally the latency appears to have been less than twenty-four hours. The onset of the attack is marked by pain coming on suddenly in the head and back, and this is followed by the usual symptoms of a bad cold. There is some fever, a furred tongue, foul breath and great prostration. After four or five days the fever subsides, and the patient is left weak and depressed, and liable to fits of chilliness, followed by sweats. Not rarely there is some delirium, even at an early stage.

Influenza does not always correspond to this description, as cases occur where the disease is much more severe in the lungs, cases in which drowsiness is a prominent symptom from the first, in which there is no fever, cases in which the disease closely resembles Typhoid Fever, etc., etc. The intemperate and the overworked, and the harassed seem specially liable to attack, and likely to have the disease severely.

The Influenza patient and what is discharged from his body are infectious from the onset of the disease, till he is well enough to resume his occupation ; this will ordinarily be in about ten days, but it may be three or four weeks.

A person exposed to infection and manifesting no symptom for six days is probably safe.

It goes without saying that, after the recovery of the patient, infected rooms and clothing should be disinfected.

PUERPERAL FEVER.

Puerperal Fever is not now regarded as an acute specific fever occurring in lying-in women only, but a puerperal septic disease caused by infectious germs directly conveyed to the patient by defiled hands, instruments, sponges, etc., or otherwise. The organisms found are similar to those found in Erysipelas and Wound Fever. Indeed infective matters from an Erysipelas patient or a Scarlatina patient, while they may cause Erysipelas or Scarlatina may also cause disease not distinguishable from ordinary Puerperal Fever.

Generally, about three days after delivery is completed, the first symptom (chilliness or actual rigors) is noticed. The onset of the disease may occur a day after confinement or may be delayed for five days. If no symptom manifests itself during the first week, the patient has not been affected during delivery. The fever, at first rather high, usually continues for about a fortnight, when there is a change for the better or worse. In very severe cases death may take place in a few days.

The patient, and all that comes from her, must be held as highly infectious from the first.

What can the Health Officer do in Puerperal Fever cases ? They are ordinarily notified to him, or should be, and he ought to take some steps to prevent the spread of the disease.

Hospital isolation is not practicable, nor can much be done for the patient, for a case is rarely notified till the patient is dying. The infected room and contents should be thoroughly disinfected. The midwife or nurse in attendance should also be urged to submit to disinfection, and to abstain from attendance on other cases for a short period.

EPIDEMIC PNEUMONIA.

Epidemic Pneumonia is an undoubtedly infectious disease, though it has been clearly recognised as such only within recent years. After inception the disease is latent from about two to five days. The first symptoms are rigors or shivering, pain in the side or over the stomach, and fever. Sometimes the pain is quickly followed by Diarrhœa and vomitting. Commonly on the second day there is Pleuro-Pneumonia on one side or both sides, followed by delirium. Cases are often fatal in three or four days. The crisis may be expected in a week or ten days, but this may be followed in a few days by a relapse.

This disease is not primarily an affection of the lungs but a fever of which Pleuro-Pneumonia is a symptom and the constitutional disturbance is usually out of all proportion to the local disease.

Debilitated persons, intemperate persons, the aged, and all living among squalid surroundings appear to be specially liable to attack and to have the disease severely.

Epidemic Pneumonia may be considered infectious from the onset of the disease till recovery from the lung disease and the patient ceases to expectorate, say three weeks, or more.

A person exposed to infection is safe, after a week's quarantine.

Had this disease been more common, or had it been more frequently recognised, it is probable it would have been included in the diseases ordinarily required to be notified; but little was known of Epidemic Pneumonia till the Middlesborough epidemic was investigated and reported on, and this was only just before the Infectious Disease (Notification) Act, 1889, was passed.

If the disease were required to be notified in any district, early cases would probably be reported and might be removed to hospital with advantage. The infected room and clothing could then be disinfected, and any sanitary defects discovered on the premises could be remedied.

Wherever else the infection of Epidemic Pneumonia may be, it is certainly in the expectoration, and as portions of this, if allowed to dry, may be carried about as infectious dust, patients should cough or spit into a piece of rag or paper to be at once burned, or into a spitting cup or vessel containing a little water, which can be emptied from time to time into a drain leading to a sewer, and cleansed with scalding water.

MUMPS.

Mumps is characterised by an inflammatory affection of the salivary glands, and of the parotid gland in particular. In the other three diseases in this group inflammation of the parotid is occasionally seen.

As to the length of the incubation period in mumps, the report of the Clinical Society Committee states that "the interval between the exposure to the source of infection and the onset of parotitis in mumps is most commonly about three weeks, a day more or a day or two less."

It is occasionally as long as twenty-five days and more rarely as short as fourteen days. There are ordinarily about three or four days of premonitory symptoms, though these amount to little more than general malaise, with some slight fever and are generally overlooked.

In a typical case the glandular swelling probably reaches ts height in about four days, and in three days later the temperature is again normal. The infectiousness in Mumps begins with the earliest symptom, and the patient is probably more or less infectious till about three weeks after the commencement of the glandular swelling.

Mumps, like Measles, is so very infectious that it has often been communicated to companions before the Sanitary Authority has had notice of the initial case. Being a disease of children and young persons, information of cases is as a rule mainly derived from school attendance officers. The Sanitary Authority can do little except recommend and try to obtain such isolation for the patient as is practicable at his home. Children from infected houses should be kept from school, and after recovery of the patient, infected things should be disinfected. It is seldom necessary to close a school on account of the prevalence of Mumps.

TETANUS.

Tetanus is a specific infective fever, the symptoms of which are not unlike those produced by the poison strychnine.

It may ensue from any wound in any part of the body, in any state of the wound, or without any apparent wound, occurring, however, more frequently when the wound is in a part exposed to earth or dirt. Twelve years ago it was found by experiment to be due to the introduction into the system of a micro-organism in soil taken from the streets or cultivated land. The spores of this organism, protected from air and light, may retain their vitality for a year or more.

The Tetanus bacillus has not only been detected in earth, but in the dirt between the boards of room-floors, and in animal excrement, especially that of the horse. The bacilli have been found to a depth of two meters from the earth surface, but not lower; they grow and multiply in manure, fields and in the stable. Sheep and oxen are often affected. As regards human beings, the disease is most common among agricultural labourers, gardeners, soldiers on campaign, bare-footed children, &c. The bacillus forms its poison exceedingly slowly, and the organism is ordinarily soon destroyed by the tissue cells.

Tetanus appears never to be produced through the bacillus being swallowed, but probably always through its being received into a wound ; the so-called idiopathic attacks being probably cases in which the wound has been so slight as to escape notice. In the human subject the period of incubation (*i.e.*, before there are even local spasms) is said to be from one to twenty-two days. The bacilli remain localised entirely in the region of the wound, but the poison they generate is absorbed from the seat of inoculation and widely diffused. The shorter the incubation period the more severe the disease.

The spores may remain latent in the tissues till long after the wound is healed,and yet finally develope into bacilli which in turn make the toxins capable of producing the muscula-spasms and tension characteristic of lock-jaw.

If the first spasms are not, as frequently they are, in the neighbourhood of the wound, they are in the muscles of the neck, jaw and face. If the symptoms go no further, the patient commonly recovers ; if the muscles of the back or side or abdomen become affected, a fatal issue may be looked for.

There is not much the Sanitary Authority can do, except by diffusing a little useful information upon the subject. So little is known at present about Tetanus that the common belief is that it is not infective, but the ordinary outcome of a severe wound between the thumb and forefinger. Indeed so ignorant are most people of the true nature of Tetanus, that it is usual for country folk to apply earth to a wound and tie up the wound with the earth in contact, probably with the idea that earth will check the bleeding.

Sanitary authorities should, by such means as are in their power, instruct the people that in respect of wounds, as in all other matters, infinite cleanliness is of the first importance. The wound should be washed till free of all foreign substances, and soaked and dressed with an antiseptic solution. The patient should be kept quiet, protected from draughts and all external irritants.

Antitoxin has been proposed as a remedy for Tetanus and it may be that in the near future some efficient way of protecting the system against the disease may be made accessible to all.

ACTINOMYCOSIS.

Actinomycosis occurs in cattle, less frequently in men. The disease manifests its presence in the form of tumours, ulcerations and abscesses in various parts of the body, especially the head and neck. The new growths characteristic of the disease, according to their gross appearances, have been called wens, polypi, cancer of tongue, lung tubercle, lumpy jaw, &c. The nature of the disease is indicated by the presence of a micro-organism, which is not in the least like Tubercle bacillus. Inside the mouth the disease appears as nodules, and attacks the jaws, especially where there are bad teeth. The disease may appear in the nasal cavities, gullet, windpipe and lungs. The wens (tumours in or just under the skin) may grow to a great size, or break down early, and discharge their contents.

In the pig, Actinomycosis commonly attacks the throat and milk glands. This disease is less widespread and, on that account, a less serious disease than Tuberculosis, but like Scrofula, it affects so many parts of the body. A carcass infected by it should not be regarded as fit for the food of man.

There is no doubt that it is spread by means of the parasitic organism associated with it, which is contained in the discharges from the broken down wens, etc. These organisms obtain access to the body, where they lodge and multiply, probably taking very many months to produce effects large enough to attract attention.

All the Sanitary Authority can do is to see that slaughter-houses, butchers' shops and cow-houses are efficiently inspected, and that no part of a carcass infected with Actinomycosis is allowed to be used for human food.

GLANDERS.

Glanders is an infective disease especially associated with the horse and ass, but occasionally attacking other animals. The malady is due to and communicated by micro-organisms (in size and general appearance closely resembling the Tubercle bacilli) which find their way into the tissues, occasioning small nodules in the skin or mucous membrane. These nodules are grey, and about the size of millet seeds, but after a time they grow, become yellowish in the centre, soften and break down. Usually the disease begins in and about the nostrils or lips, affecting frequently the respiratory passages and lungs. Secondary abscesses occur in various parts of the body, the infecting material being apparently carried by the blood or the lymph stream. When the disease, instead of being in the respiratory tract, is under the skin in various parts, causing nodular swellings along the lymphatics it is called "Farcy." In man it usually takes this form.

In the early stage of the disease in the horse, there is commonly a copious discharge of water or watery matter from the nostrils. By this and the softened contents of the nodules the disease is spread. The nodules, after discharging their contents, form ulcers and run into one another.

Glanders and Farcy are not always acute forms of disease but may both be chronic. The disease is, however, always infective. Indeed, the so-called "Occult Glanders," the only external manifestation being occasional slight nasal discharge, is infective. As Glanders is readily and directly communicated by the nasal discharges, characteristic nodules are soon produced probably in from a few days to a fortnight. The intensity of the disease is proportionate to the rapid formation and softening of the nodules. The human subject, like the horse, may be inoculated through wounds or scratches, or through the application of the nasal discharge of a Glandered animal to the mucous membrane of the nose or mouth. Acute Farcy in man runs a very rapid course, the average period being from two to three weeks, and perhaps one patient in ten may recover.

At a temperature of 77 deg. Fah. the bacilli grow and develope outside the body, especially in such material as fodder, manure and stable refuse. However, a temperature of 131 deg. Fah. continued for ten minutes is sufficient to destroy the bacilli.

A stable which has been occupied by a Glandered horse may remain infective for some weeks. It may be efficiently disinfected by good washing with boiling water. A solution of carbolic acid (containing 4 per cent.) applied to the nasal discharge will make it innocuous in a minute.

The duties of the Local Authority as regards Glanders are to disseminate information about it; to see that all cases are duly reported and dealt with, so as to prevent the spread of the disease; and to inspect, more efficiently than is usual, all knackers' yards, and prevent the sale of Glandered carcasses.

HYDROPHOBIA OR RABIES.

Hydrophobia or Rabies never arises spontaneously, and in the human subject the onset of the disease has always borne a definite relation to some such injury as the bite of a rabid dog or cat which may afterwards have developed symptoms of Rabies. Besides the animals mentioned, horses, deer, rabbits and guinea-pigs may be affected. The material causing the disease is contained in the saliva of the animal, which, in biting a man or animal, transmits the poison. There may be no symptoms for a month or two, and in some cases for a year. Then the wound becomes slightly itchy and uncomfortable, and later on grows exceedingly hot and painful. In a short time the patient is feverish and thirsty, pale and anxious looking. The facial muscles are drawn, and the expression of the face is one of horror. On the second or third day the patient becomes much more excited and restless, and looks suspicious. With increased fever comes rambling delirium, and with increased thirst difficulty in swallowing, till the very sight of water terrifies the patient. Next muscular tremors come on and increase, and violent spasms (as in Tetanus) are readily stimulated. Finally, the spasms increase in intensity and frequency, and the patient dies at last suffocated.

Only a certain proportion of those bitten by a rabid animal develope Hydrophobia.

M. Pasteur, finding that fluids and tissues taken from a rabid animal varied in their virulence, that virus could be intensified or modified and that different animals were affected in different degrees by the same virus, set himself to discover whether it was possible so to alter the resistance of an individual that a virulent Hydrophobic material would have little or no effect on the tissues. How he solved this problem it would be out of place to describe here. Suffice it to say that he did solve it satisfactorily; this there is now abundant evidence to prove.

The first human being inoculated against Hydrophobia was Joseph Meister (aged 9 years), who, on July 4th, 1885, was severly bitten on arms and legs by a dog which was undoubtedly mad. The worst of the wounds were treated with carbolic acid, but not till twelve hours after they had been inflicted, so that in the ordinary course there would have been little prospect of the child escaping Hydrophobia. The child never had the faintest symptom of the disease. Since that time an enormous number of patients have been inoculated, and the percentage of deaths after inoculation has been very much lower than among patients not inoculated.

M. Pasteur's researches on the production of immunity against the attack of this disease were carried on under the conviction that in Hydrophobia the exciting cause is a poison, the most probable source of which is a vegetable organism. Drs. Woodhead and Wood explain the result of Pasteur's treatment by saying that the treatment consists in causing the tissues to acquire a tolerance before the microbe has had time to develope. The tissue cells are acted upon by increasingly active virus, each step of which acclimatises the cells for the next stronger virus until at length, when the virus formed by the micro-organisms introduced at the time of the bite comes to exert its action, the tissues have been so far altered or acclimatised that they can continue their work undisturbed in its presence ; and, treating the micro-organisms as foreign bodies, destroy them. Thus the factor of time between the bite and the beginning of the treatment is most important, and other things being equal, the greatest success is obtained with patients treated within two or three days of being bitten.

The duties of the Local Authority as regards Hydrophobia or Rabies are obvious. First, such steps should be taken as may be practicable for informing the public as to the nature of this disease. Secondly, the authority must, of course, see that all cases are duly reported and dealt with, so as to prevent the spread of the disease. In the third place, a combined attempt should be made by all Local Authorities to continue to require the muzzling of all animals liable to take and communicate the disease till it is stamped out. Finally, arrangements should be made for sending to the Pasteur Institute any human being bitten by a rabid animal as promptly as possible. In India there are two such Institutes, one in Koonoor and the other in Kasauli. Government pay all expenses to poor people and to all their servants including railway fare and the cost of living at the place. Similarly, other public bodies have to pay expenses for their own servants.

PERIOD OF ISOLATION OF THE INFECTED IN VARIOUS INFECTIOUS DISEASES.

Varicella (Chicken-pox).—Until every scab has fallen off, particular attention being paid to the scalp.

Diphtheria.—In no case for less than four weeks, and until convalescence is completed, and there is no longer any sore throat or any abnormal discharge from the throat, nose, ears or eyes, no cutaneous pustulation and no albuminuria, and at least two successive bacteriological examinations of the pharyngeal and nasal mucus for the specific bacillus have been attended with negative results ; each examination having been made not less than twelve hours after the discontinuance of local antiseptic applications.

Rubeola (German Measles) and Epidemic Roseola.—For not less than ten days from the date of the appearance of the rash.

Morbilli (Measles).—For not less than two weeks from the date of the appearance of the rash, convalescence being satisfactorily established.

Mumps.—For not less than two weeks from the commencement, provided that one clear week has elapsed since the complete subsidence of all swelling.

Scarlatina (*Scarlet Fever*).—For not less than six weeks from the date of the appearance of the rash, until convalescence is completed, and there is no sore throat, discharge from the ear or nose, suppurating or recently enlarged glands, or eczematous patches.

Variola (*Small-pox*).—Until every scalp has fallen off and the skin lesions have all healed.

Pertussis (*Whooping Cough*).—For not less than five weeks from the commencement of the whooping, and until the characteristic spasmodic cough and the whooping have ceased for at least two weeks.

Table of Incubation and Quarantine Period in Days.

	Incubation.	Average.	Quarantine.
Varicella (Chicken-pox) ..	11–19	14	20
Diphtheria ..	2–10	5	12
Rubeola (German Measles) ..	9–18	14	20
Epidemic Roseola ..	9–18	14	20
Morbilli (Measles) ..	10–14	10	16
Mumps ..	14–23	21	24
Scarlatina (Scarlet Fever) ..	2–8	4	10
Variola (Small-pox) ..	10–14	12	16
Whooping Cough ..	7–19	14	21

HOUSE FLY.

The part which the ordinary house fly plays in propagating infectious diseases is now well-known to all scientists. It has been proved beyond doubt that Typhoid Fever, Cholera, Summer Diarrhœa and such other diseases can be spread by the flies sitting on the evacuations from persons suffering from these diseases and then contaminating the food supply. It is therefore necessary to know the habits, life-cycle and breeding places of these pests, which are explained in the following pages.

The system of refuse removal in the City of Bombay aims at preventing a single dust-bin remaining unattended to in the course of the day. But the most important point is that no refuse, etc., should remain clinging on the side and crevices of these carts, as such places may afford a nidus for the flies to deposit their eggs. For this reason it is absolutely necessary that all carts should be washed at least once in every seven days. There is a standing order of the Health Department to this effect.

As regards human excreta, there is no doubt that basket privies in the native quarters provide breeding and feeding ground for flies. In order to minimise this nuisance, the system of removal twice a day has been introduced so as to prevent accumulation. The most serious nuisance that is observed everywhere is the practice of allowing young children to defæcate in public streets, alleys and passages. In all the Presidency Magistrates' Courts this offence is considered punishable under Section 372 of the City of Bombay Municipal Act. This filthy habit must be checked by repeated prosecutions of the parents.

There now only remains the question of stable refuse accumulating in licensed and unlicensed stables. Such heaps of refuse, especially in the monsoon, afford suitable breeding places for these flies. It is therefore very necessary to enforce the Sections of the Act bearing on the subject, especially Section 372. It is also desirable to treat such heaps every three days with a solution of pesterine as the latter is a known insecticide.

LIFE-HISTORY OF MUSCA DOMESTICA.

(*Ordinary House Fly.*)

The house fly undergoes a complete metamorphosis, in which there are four well marked stages; these stages in the life-cycle are:—

(1) The egg (ovum), commonly known as "fly-blows."
(2) The larva, or maggot stage.
(3) The pupa, or chrysalis stage.
(4) The imago, or perfect fly. (The final stage).

1st Stage.—The eggs are laid in small irregular clusters, or in large collective masses, consisting of many thousands of individual eggs. They are almost invariably deposited on or in such substances as will provide food for the larvæ or maggots. They are usually placed in narrow crevices near the surface, but occasionally also at a distance of from

4 to 6 inches below the surface, the favoured spots in all cases being *fermenting vegetable matter* or the refuse lying immediately over such materials, or the refuse that is likely to ferment. They are often laid, however, on materials which do not ferment, and in all such cases the developmental cycle is greatly prolonged.

The eggs are pure white, and present a highly polished surface due to the clear viscous substance with which they are coated. The larvæ or maggots hatch from these in periods varying from 8 hours to 3 to 4 days; the average time may be given as 12 hours, but when laid in fermenting materials the incubation period is reduced to a minimum of 8 to 12 hours.

The number of eggs laid by a single fly averages from 120 to 140. More than one batch may be laid during the life of the fly, but this point has not been definitely settled.

2nd Stage.—The *larva or maggot* resembles that of the common "Bluebottle fly" or "Blow fly", but is much smaller, measuring when fully matured nearly half an inch in length and is distinguished also by certain anatomical characters. It is essentially a vegetable feeder; animal matter is eaten only when in the form of human fæces. It has never been found feeding on the carcasses of dead cats and dogs, or of birds and fish remains.

The larvæ thrive and mature most rapidly, and are always most abundant in *fermenting* materials; but they can also mature in non-fermenting substances during warm weather though very slowly.

In stable manure they are generally most numerous a few inches below the surface, and they work their way upwards day by day into fresh material a few hours (5 to 6) after it has been added to the previous accumulation. This marked habit is evidently due to the excessive heat which is engendered in the lower strata of the manure.

They mature in 5 to 8 days under the most favourable conditions as to temperature and food supply; but when fermentation does not take place, this stage, even in hot weather may be prolonged to several weeks (6 to 8). In ash pits they locate themselves in various materials as well as ashes, but are evidently partial to old bedding, paper and rags, usually in or near the centre of fermentation. After emptying the alimentary tract of organic matter, pupation takes place rapidly, and the third stage is reached.

3rd Stage.—The *pupa or chrysalis* is at first of a pale yellowish colour, but rapidly changes to bright red and finally to a dark chestnut colour. It is somewhat barrel shaped and varies in length from $\frac{2}{12}$ to $\frac{3}{12}$ of an inch. Small examples are found where the temperature has been low or excessively hot and somewhat dry. Large examples invariably occur in fermented materials, more especially so in stable manure.

In stable middens the pupæ occur chiefly at the sides or at the top of the wall or framework of the receptacle where the temperature is lowest. In such situations they are often found packed together in large masses numbering many hundreds. The flies emerge from the pupæ, under the most favourable conditions, in five to seven days. In all cases where heat is not produced by fermentation, the pupal stage may last from 14 to 28 days, or even considerably more.

4th Stage.—The perfect fly escapes from the pupa by breaking away the anterior end; this it accomplishes by inflating the frontal sac, which is situated between the eyes. By the inflation of this sac, the fly is also enabled to force its way through the manure or ashes into the open air. When once it has liberated itself, the wings develope, and when the integument has sufficiently hardened the fly takes to wing. Pairing then takes place, eggs are laid and another generation is started. The whole cycle from egg to perfect insect occupies, under the most favourable conditions, from 10 *to* 14 *days*; but in low temperatures the whole cycle may extend to several weeks.

Habits of the Flies.

The flies migrate from their breeding places to dwelling houses in order to obtain food and shelter. They have a *persistent habit of feeding or alighting upon human excreta* and thus play a very important part in the transmission of zymotic diseases.

Professor Robert Newstead of the Liverpool School of Tropical Medicine carried out a long series of systematic investigations on this subject; he observed flies sitting on patches of human excreta in the courts and passages of Liverpool houses and the same thing is observed in native houses in India.

Effect of Temperature.

Temperature has a most marked effect upon the developmental cycle of the fly; and a sudden check from heat to cold will materially prolong any of the stages.

The larvæ or maggots mature in the shortest period in fermenting materials in a temperature of between 90° and 98° F., but they usually leave the hotter portions of the stable manure when it reaches a temperature of 100° to 110°. In 54° F. both larval and pupal stages are considerably prolonged.

Mr. Newstead summarises his conclusions as follows:—

i. The chief breeding places of the house fly are—
  (*a*) Stable middens containing fermenting horse manure or a mixture of this and cow-dung.
  (*b*) Ash-pits containing fermenting vegetable matter, in about 25 per cent. of the total number of pits examined.

ii. Covered ash-pits and middens were as badly infected as those which were open.

iii. House flies breed in all temporary collections of fermenting matters.

iv. House flies breed in relatively small numbers in ash-pits where no fermentation takes place.

v. They do not breed in ash-pits which are *emptied at short intervals*, or in the patent bins.

vi. The use of disinfectants in ash-pits does not prevent the flies breeding in such receptacles.

vii. Very dry or excessively wet ashes and moist cow-dung do not harbour them. (In exclusively hot summers cow-dung may form a breeding place for the house fly. The admixture of a large quantity of bedding (straw or saw-dust) would also render it suitable for breeding purposes.)

viii. The presence of fowls (not ducks or geese) which had free access to the stable middens reduced the number of larvæ and pupæ to a very marked extent.

ix. The life-cycle of the fly in all kinds of fermenting materials is reduced to the minimum period of 10 to 14 days ; and in the absence of such artificial heat the cycle may occupy a period of from 3 to 5 weeks or more, according to the temperature of the outside air.

x. House flies do not depend entirely upon excessively warm weather for breeding purposes, though in hot seasons they would breed much more rapidly in non-fermenting materials, and their numbers, under such conditions, would be greatly increased.

Mr. Newstead further makes the following suggestion to reduce house flies to a minimum :—

(1) Stable manure should not be allowed to accumulate in the midden steads for a period of more than seven days.

(2) All midden steads should be thoroughly emptied and carefully swept. The system of *partly emptying* such receptacles should in all cases be discontinued. The walls of midden steads should also be cemented over ; or failing this, the brick work should be sound and well-pointed.

(3) All ash-pits should be emptied during the summer months at intervals of not more than ten days.

(4) The most strenuous efforts should be made to prevent children defæcating in courts and pass sages ; or the parents should be compelled to remove such matter immediately ; and defæcation in stable middens should be strictly forbidden.

The danger lies in the overwhelming attraction which such fæcal matter has for house flies, which latter may afterwards come into direct contact with man or his food stuffs. They may, as Dr. Veeder puts it, " in a very few minutes . . . load themselves with dejections from a Typhoid or Dysenteric patient not as yet sick enough to be in hospital or under observation, and carry the poison so taken up into the very midst of food and water ready for use, at the next meal. There is no long round-about process involved."

(5) Ash-pit refuse, which in any way tends to fermentation, such as bedding, straw, old rags, paper, waste vegetables, dirty bedding from the " hutches " of pet animals, etc., should, if possible, be disposed of by the tenants preferably by incineration, or be placed in a separate receptacle so that no fermentation could take place. Pesterine—crude petroleum—kills larvæ and eggs and prevents the breeding of flies.

(6) The application of Paris Green (containing arsenic, copper and acetic acid) at the rate of 2 oz. to one gallon of water to either stable manure or ash-pit refuse will destroy 99 per cent. of the larvæ.

One per cent. of crude atoxyl in water kills 100 per cent. of fly larvæ. (Care should be taken that cattle do not eat the straw treated with this poison).

(7) The use of sun-blinds in all shops containing food which attracts flies would largely reduce the number of flies in such places during the hot weather.

(8) The screening of midden steads with fine wire gauze would, undoubtedly, prevent flies from gaining access to manure, etc., but it is very doubtful if this method would meet with any marked success. The gauze would rapidly oxidise, the framework supporting it would probably warp and a number of flies would be admitted whenever the receptacle was opened.

CHAPTER VII.

MALARIA AND MOSQUITOES.

Malarial Fevers are the class of fevers caused by the specific organisms named plasmodia of Malaria, belonging to the class "Sporozoa," whose definite host is the mosquito, and whose intermediate host is man and other vertebrates. In man these parasites inhabit the red blood corpuscles, giving rise to fever usually of a periodic character, anæmia, enlargement of the spleen and the deposit of a black pigment in the viscera and elsewhere. These fevers, if recognised at a sufficiently early stage, always yield to proper treatment by quinine.

In 1880 Laveran, a French surgeon, discovered that Malarial Fevers are caused by a special organism which is present in the blood of patients suffering from the disease. It is composed of one cell only and belongs to the class "Protozoa." It is thus a single undivided cell of protoplasm. Secondly, it is a parasite which passes its life in and at the expense of other animals, which are called its *hosts*. The plasmodium is often called the "*Malarial Parasite*." This parasite, like all protozoa, is provided with a nucleus and the substance of which its body is composed has the same general properties as the protoplasm of the cells which build up the tissues of the higher animals; it moves, it assimilates food, it grows and divides and it produces by chemical processes a variety of chemical compounds.

Reproduction is of 2 kinds, *viz.* asexual and sexual.

The *asexual method* consists simply in the division of a fully grown parasite into a number of smaller ones, each of which is exactly similar, excepting in size, to the original one.

The *sexual method* consists essentially in the union of two individuals, which have acquired different properties (male and female) followed by growth of the fertilised cell and its division into a number of smaller cells, each of which becomes a parasite exactly similar to the original one. All protozoa, at the commencement of their life, multiply by the asexual method only, and after a certain number of generations have been produced by this method, sexual forms appear which are capable, under suitable conditions, of carrying on multiplication by the sexual method.

The sexual cycle commences in the blood when the conditions are unfavourable for the continuance of the asexual cycle and has been taken as a sign that the patient has already developed immunity against the fever-producing young parasites.

After a certain number of asexual generations have been formed, sexual forms appear, which, if transferred to the body of another host (mosquito), can by a process of fertilization and subsequent growth and division, produce forms which, when re-transferred to the original host, develope into entirely young parasites with as much energy for asexual production as was possessed by the original organism.

There is yet *a third method of reproduction* known as *Parthenogenesis*, meaning the production of a number of small parasites from a fully mature female parasite which has *not been fertilised* by the male element. It is said that the female forms of the parasite are capable of continuing to live in the blood long after all other forms have died off, and that, perhaps months or even years after a patient has apparently recovered, chill or shock to the system may rouse these forms to renewed activity, when they produce themselves parthenogenetically and cause the appearance of a fresh crop of young parasites in the blood, thus occasioning a "*relapse*." There is no evidence at present that the parasite passes into the ovum giving rise to hereditary transmission.

The following is the complete life history of the Malarial parasite :—

The young form of the parasite called (*Schizont*) enters the red blood corpuscles of a man. Under the microscope it is seen as a small unicellular mass of protoplasm, undergoing amœboid movement and occupying but a small portion of the whole corpuscle. It gradually grows larger, feeding upon the substance of the red blood corpuscle and converting the hœmoglobin into dark granules of pigment (*melanin*) which can be seen in the parasite. When it has grown to its full size so that it nearly or quite fills the corpuscle, the grains of pigment collect together into a mass and the parasite begins to divide up into a number of small parts or segments called *spores*, each of which is capable of becoming a new parasite identical in all respects with the original one. These spores remain in contact with each other for some time and then burst through the red blood corpuscles and become free in the blood. Each of them now seeks out and enters a red blood corpuscle, in which it begins to grow in the same way as the original one did, ultimately reaching its full size and dividing up into a number of parasites, which again enter other corpuscles and go through the same cycle. This is the *asexual method* of multiplication called *Schizogony*.

Having attained their full size, they appear as coarsely pigmented, round or crescent shaped bodies enclosed within the thin shell of the red blood corpuscle. *In the blood of man, they undergo no further development, and gradually die off*. The sexual cycle consists of two elements : the male and female. When a mosquito of the anopheline variety bites a person with these sexual forms of parasite in his blood, some of them are carried into the mosquito's stomach with the blood which the insect extracts and undergo further development. Aided by the digestive action of the stomach juices, the thin end of the red blood corpuscle becomes disintegrated and the parasite escapes and gets free in the fluid of the mosquito's stomach. Then the female sexual form becomes a granular spherical body. The pigment of the male sexual form becomes scattered and 3 or 4 long filaments are suddenly protruded from the periphery. These filaments are called *microgametes*. These filaments then break off and swim about in the fluid in the mosquito's stomach. They are the true male element in the sexual process. When one of them meets a female sexual form, it enters it and fertilises the true female element (*macrogamete*) contained in it. After this fertilization the female parasite changes its shape, becoming ovoid with a pointed end and is called *Ookinet*.

This moves about and makes its way to the inner wall of the stomach, resting between the epithelial and muscular layers. Here it grows and attains a large size when it is called *Zygote* (Oocyst). Thus zygote is a female fertilised cell or egg.

By a process of division called Sporogony (as distinguished from Schizogony) an enormous number of embryo parasites called *Sporozoites* are formed in the full-grown zygotes. The capsule of the zygote bursts after some time and the sporozoites are then liberated into the lymph sinuses which surround the outer surface of the stomach. Hence they are conveyed by the circulation to the salivary glands, resting in the gland cells and in the salivary duct which has its external opening at the point of one of the piercing stylets of the proboscis. From here they are injected into the blood by the mosquito and they then attach themselves to and penetrate the red cells producing a new infection. This process of development in the mosquito takes about 10 to 12 days.

The asexual cycle is called the *cycle of Golgi,* producing auto-infection of the patient. The sexual cycle is called the *cycle of Ross* producing a new infection in a healthy subject. The sexual cycle is also known as Sporogony while the asexual is called Schizogony.

At first, while the number of parasites introduced through the mosquito's proboscis is small, the infected person may remain apparently well. When, however, the number is large enough, he begins to suffer from fever.

The parasites tend to produce their spores all at the same time and it is at the moment when these spores escape that the patient's fever begins.

The fever is probably caused by a little poison which escapes from the parasites with the spores. After from 6 to 40 hours or more this poison is eliminated from the patient's system, and his fever then leaves him temporarily. In the meanwhile, another generation of parasites may be approaching maturity and may cause another attack of fever like the first, and so on indefinitely for weeks or months. In this manner the attacks of fever follow each other at regular intervals. But it often happens that before one attack has entirely ceased another commences; so that the attacks overlap each other and the fever is continued. After a time, even without treatment the number of parasites may decrease, until not enough of them are left to produce fever, when the patient improves temporarily. It generally happens that sooner or later the number of parasites increases again, when the patient again suffers from another series of attacks. Such relapses are frequently encouraged by fatigue, heat, chill, wetting, dissipation and attacks of other illness. They may occur at intervals for many years after the patient was first infected and after he has moved to localities where there is no Malaria. It is probable that, as long as one parasite remains alive in the patient's blood, he may remain subject to such relapses.

Besides fever, the parasites produce Anæmia, enlargement of the spleen, especially in chronic cases.

Death is sometimes caused by sudden and grave symptoms If the patient survives, the parasites tend to die out of themselves without treatment after a long period of illness, leaving him more or less "immune."

The parasites are of at least three kinds, *viz.*, (1) those producing quartan fever, (2) those producing tertian fever and (3) those producing so-called malignant fever in which dangerous complications most frequently occur.

Cinchona bark and quinine possess the power of destroying the parasites and curing the infection. But it cannot destroy all the parasites in the blood unless it is given in sufficient doses and continued for several months.

Mode of infection.—While on the subject of reproduction the mode of infection has been already alluded to, *viz.*, when Anopheline mosquitoes happen to feed on a patient whose blood contains the parasites of Malaria, these are drawn with the blood into the insects' stomach. If the sexual forms are present, these undergo certain changes in the mosquito's stomach and ultimately the spores find their way into the insect's salivary gland. The insect then injects through its proboscis under the human skin when it commences to feed, and the spores are also injected with the fluid secreted from the salivary glands.

Thus the parasites of Malaria pass alternately from men to certain mosquitoes and back from these mosquitoes to men.

Thus Malarial Fever is an infectious disease which is communicated from the sick to the healthy by the agency of certain mosquitoes.

The parasites of Malaria have never been found in the water or air of marshes ; nor in decaying vegetation ; nor in the soil. But the Anophelines which carry the parasites breed in marshes and marshy pools and streams.

Rising from these marshes they enter the adjacent houses and feed on the inmates mostly at night, biting first one person and then others and living for weeks and months.

If an infected person happens to be present in any of these houses, the infection is likely to be carried by the Anophelines from him to other inmates, and to neighbouring houses. Thus the whole neighbourhood tends to become infected and the locality is called "malarious." In such localities it is easy to find the parasites of Malaria in the Anophelines of the proper species.

Such Anophelines when taken from a malarious locality to a healthy one will still infect healthy persons whom they have been caused to bite.

So also, in malarious localities, the Anophelines bite the healthy new-born children and infect many of them. Such children, if not thoroughly treated, may remain infected for years ; may become anæmic and possess enlarged spleens ; and may spread the infection to others. Later, however, at the age of 12 years or more, the survivors tend to become "immune."

In many malarious localities almost every child has been found to contain the parasites of Malaria or to possess an enlarged spleen. In such a locality, therefore, the infection is constantly passed on from the older children,or from adults, to the new-born infants ; so that the locality may remain malarious for years or for centuries. Similarly, a new-comer arriving in such a locality is very likely to become infected, especially if he sleeps in an infected house even for one night.

A locality is said to be *malarious* only when healthy persons become infected in it ; not when persons who have become infected elsewhere happen to reside in it. A locality is malarious only when it contains persons already infected with parasites, and also sufficient numbers of the proper species of Anophelines to carry the infection to healthy persons. The chances of infection tend to be great in localities where there are already numerous infected persons, not treated with quinine, or where there are numerous Anophelines of the proper species not prevented from biting. Conversely, the chances of infection tend to be less where infected persons are excluded, or properly treated with quinine ; or, where the Anophelines are few in number or are prevented from biting.

Duration of Infection.—The parasites remain in the blood while the fever lasts, *i.e.*, in untreated cases, for some weeks or months, at least. Ross has found the parasites in several persons after residence in England for six months. The infection occasionally remains for some years.

What becomes of the parasites between relapses.—Marchiofava and Bignami are of opinion that they enter upon a latent phase in the interval. Ross says that the parasites simply vary in numbers within the body, as the tubercle bacillus does. When they are numerous the patient suffers ; when they are few he does not feel them.

It is easy to estimate the number of Malarial parasites in a patient by comparing them under the microscope with the number of red blood corpuscles. In severe cases the number of parasites may exceed 10 per cent. of the number of red blood corpuscles.

Causes of Relapses.—The varying resistence of the host is the chief factor which causes the parasites to increase and decrease. When the resistence is great, the parasites diminish ; when it weakens, they multiply. Fatigue, heat, chill, dissipation and illness tend to encourage the parasites and to precipitate a relapse. Every planter knows that when his coolies are first put upon the heavy work of the season, scores of them suffer from fever. Engineers often observe the same phenomenon. The frequency with which relapses of Malaria follow upon other diseases, such as Pneumonia, Influenza, Typhoid and Venereal Diseases, or upon child-birth, accident and surgical operations is well-known. The intermittent tendency is apt to be impressed on all diseases occurring in old cases of Malaria.

The "hot weather rise" in the Malaria admission-rate is due to relapses by the rapidly increasing heat of the tropics. Ross is of opinion that great external heat is favourable to the parasites of Malaria, both human and avian. Thus he explains the obstinacy of cases in the hot weather and the great improvement caused by removal to a hill station or to Europe.

The most important facts which we have learnt so far may be summed up as follows :—

1. Malarial Fevers are caused by the presence, in the blood of the patients, of a small parasitic animal belonging to the lowest grade of the animal kingdom, the *Protozoa*.
2. This parasite passes its life in two hosts, *viz.*, man and Anopheline mosquito.
3. In man it multiplies itself by a process of simple division for some time, and then produces sexual forms, which for their further development require to be taken into the body of the second host, which is an Anopheline mosquito.
4. This is effected when such a mosquito bites a man with those forms in his blood.
5. In the mosquito's body the female sexual form is fertilised by the male, the cell which results being called a zygote. By the growth and division of the zygote an enormous number of new forms of the parasite, called sporozoites, are produced, which become lodged in the salivary or poison gland and duct of the mosquito.

6. When this mosquito bites another man, some of the sporozoites are injected into him with the salivary fluid.

7. In his body they develop into the young parasitic animals in the red blood cells, exactly identical with the original ones.

8. As the Malarial parasite does not pass any part of its life in any other environment than men and mosquitoes, it follows that men and mosquitoes are the only sources of infection of Malarial Fevers.

9. It has been proved, almost beyond any possible doubt, that there is no other method by which Malarial Fevers are contracted in nature than by the bite of a properly infected Anopheline mosquito.

10. We cannot contract Malarial Fevers from drinking impure water, or from the soil, or by breathing impure air; and water and air are only indirectly connected with Malarial infection in the sense that they are the homes of the Malaria-carrying mosquitoes.

Proper duration of treatment.—By treatment is meant treatment with the specific quinine, given in any of the methods usually adopted by medical practitioners. How long should it be continued in order to extirpate the infection entirely? Ross considers three months in temperate climates and four in the tropics (in view of the observation that the parasites flourish more readily in the latter). If a relapse occurs within these periods, the treatment must be recommenced from the beginning. Warnings against reinfection should always be given.

It is bad economy as well as bad medical practice to return men (coolies, soldiers, etc.) to duty or at least to release them from observation and outdoor treatment, before a complete extirpation of the infection has been effected. Not only do they tend to be useless as workers, but they also spread infection amongst the healthy and thus act as *Malaria carriers*.

What is meant by the *amount of Malaria in a locality?* We first divide the cases into *imported* and *indigenous* cases: *imported* means those who were infected outside the locality and *indigenous* those who were infected within it. The ratio of the numbers of each class to the total population of the locality might be called, respectively, *imported Malaria rate and indigenous Malaria rate.*

When we talk of the *amount* of *Malarial Fever* in a locality we include both classes, since imported as well as indigenous cases may suffer from relapses in it. But if we talk of the amount *of Malaria* in the locality we generally mean the amount of Malaria which is or has been contracted within it, *i.e.*, indigenous cases only (Ross).

The total Malaria rate of the locality will represent fairly accurately the *indigenous* Malaria rate.

The infection rate varies even in the same place from year to year. The number of infections occurring in a locality during any interval of time depends upon the number of infected Anophelines, which in its turn depends on the number of Anophelines which have bitten previously infected persons.

Measurement of Malaria in a locality.—There are four ways of ascertaining the amount of Malaria in a locality:—

(1) Examination of statistics in hospitals and dispensaries: the number of admissions for and of deaths from Malaria.

(2) Examination of children under 16 years of age, observing to what extent enlargement of the spleen is present among them; this is the easiest of the direct methods and can be accomplished in a few seconds.

(3) Microscopical examination of the blood of persons living in the locality, with a view to detecting the presence of the Malarial parasite; the proportion of persons with parasites in the blood is termed the "endemic index."

(4) Examination of the Anopheles mosquitoes in the locality, noting the species which are prevalent and specially the number of them which show Malarial parasites in their bodies.

For spleen, children under 16 years of age are examined for various reasons, the chief of which are that—

(*a*) children are easily accessible in schools or in villages ;

(*b*) adults in many cases have become partially immune.

As regards spleen measurement, Ross ascertains also the degree of enlargement, *i.e.*, whether the enlargement is small, medium or great. As a rough estimate, he takes the "small," "the medium," and "the great" enlargements as being respectively three, six and nine times the size of the normal spleen, which is taken at unity. Hence by adding together the children with no enlargement, three times the children with small enlargement, six times and nine times those with medium and great enlargements and dividing by the total number examined is obtained what he calls the *average spleen*. It is likely to give a more delicate index of the amount of Malaria in a locality than the mere spleen rates. If the spleen rate of a locality is not higher than 5 per cent., there is likely to be little endemic Malaria there. In the case of

(1) a healthy area, the average spleen rate amongst children is not above 10 per cent. ;

(2) a moderately endemic area, it is between 10 and 25 per cent. ;

(3) a highly endemic area, it is between 25 and 50 per cent. ;

(4) a hyper-endemic area, it is above 50 per cent.

Ross suggests that the term *parasite rate* should be applied to the above ; that the term *spleen rate* should be given to the proportion of people with enlarged spleen due to Malaria and that the term *endemic index* should be reserved for both together.

For practical purposes the parasite rate can be determined for small populations; and for large ones we must resort to the spleen rate.

Facts about Mosquitoes.

Gnats, commonly called mosquitoes, belong to the zoological family of insects known as the Culicidæ. They are distinguished from other insects by a number of characters; they possess *only one wing* on each side, and a long proboscis.

Their life is divided into four stages: the egg, the larva, the pupa and the imago.

The *egg* is laid on water or near it, and in warm, moist weather hatches out *in a day or two.*

The *larva* is entirely aquatic, and always lives in water. It swims and dives by means of paddles and hairs and feeds on various aquatic organisms. It cannot, however, breathe under water, but must always rise to the surface in order to obtain air. After a *week or more* it becomes a *pupa.*

The *pupa* still remains in the water, generally floating on the surface. After *two days or more* its skin cracks and the *imago* emerges.

The *imago* remains standing for a little while on the empty floating skin of the pupa and then flies away. Both males and females are able to suck fluid through the proboscis. As a rule, the male feeds only on the juices of plants; but the female sucks the blood of men, beasts, birds and reptiles. The female returns to water every few days in order to lay her eggs, of which she may deposit several hundred at a time; and then seeks another meal.

Female gnats have been kept alive in captivity for months. In unsuitable weather, both males and females may take refuge in damp places such as cellars, wells, out-houses and woods, where they remain dormant for months until better conditions prevail.

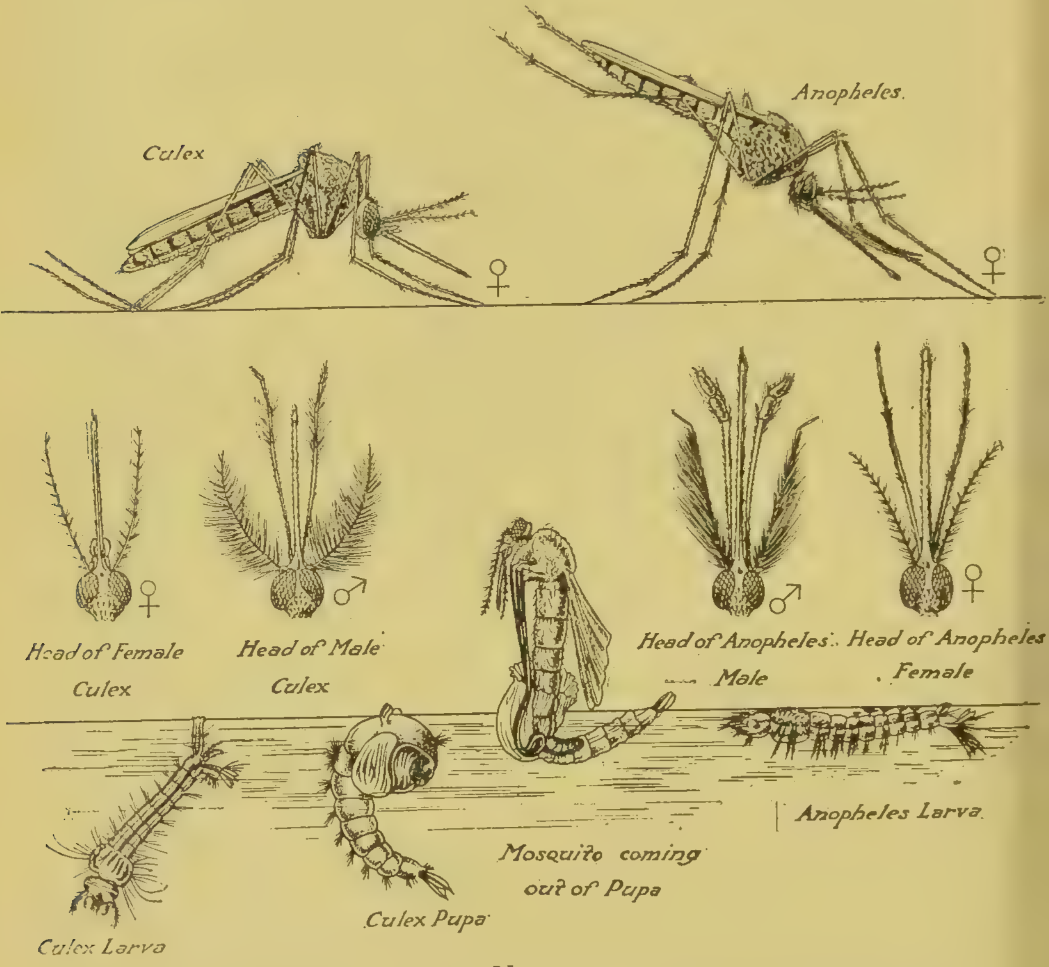
As a rule, gnats like other animals tend to remain in the locality where they were born; but a few may occasionally stray to some distance. When a strong wind prevails they usually take shelter; but on warm, still nights or days many of them may wander to a distance of half a mile or more from their breeding places. If, however, plenty of places exist near at hand where they can obtain food, there is no reason why they should travel further for it. They must remain near water to drink and to lay their eggs in.

Gnats are favoured by warm weather, by plenty of water suitable for their larvæ; by abundance of food; and by the absence of various kinds of bats, birds, fish, insects and spiders which devour them or their larvæ. During its life, a single gnat may succeed in biting many persons or animals, and in propagating disease amongst them.

In the tropics, the gnats which most concern human beings belong to the groups called Culex, Stegomyia and Anophelina.

The Anophelines consist of about 120 known species, some of which carry Malaria, and are always found in malarious places. The larvæ occur chiefly in water on the ground, particularly in water which stands or flows amongst grass or water weeds. Thus they abound in the weedy margins of rivers, streams, lakes and ponds; in small sluggish streams and streamlets; in water-courses, drains and gutters choked with weeds; in pools of rain water lying on grass; in pits from which earth has been removed, such as "borrow pits" by the side of railway embankments; in cisterns and pits used for watering gardens; in ornamental waters; in hollows or rocks; and in water at the bottom of boats, etc. Anophelines are principally *marsh mosquitoes*. The larvæ feed chiefly on the surface of water, on which they float like sticks, and not with the head hanging downwards. When disturbed, they swim away backwards on the surface and sink to the bottom only when much alarmed. They have no breathing tubes like those of Culex and Stegomyia. The adults are speckled brown and white, or black and white; and the wings are not plain, but generally possess 3 or 4 black marks along or near the front border. When the insect is seated at rest on a wall, the tail projects outward at an angle from the wall; whereas the Culex and Stegomyia sit with the tail hanging downwards or even nearly touching the wall. Anophelines bite chiefly at night or in the dusk, owing to which the Malarial infection is generally acquired at night. They enter houses, but also bite in the open in spots sheltered from wind.

Culex and Anopheles Mosquitoes.



No. 1.
This shows larva, pupa and adults of both Culex and Anopheles.
(l'Institute Pasteur de Paris).

The following table shows the differential characteristics of the eggs, larvæ and adults of Anopheline, Culex and Stegomyia :—

	EGGS.	LARVÆ.			ADULTS.				
		Attitude.	Breathing Tube.	Movement.	Habitat.	Attitude.	Wings.	Bite.	Parasites.
Stegomyia.	Float separately.	Float with head downwards.	Short and stumpy.	Sink.	Tubs, pots, drains, holes, gutter on roof, hole in a tree, hollows in rocks, broken glass on top of walls, and vases in cemeteries.	Parallel to the wall. Hunchbacked.	Plain.	Day-time.	Yellow Fever.
Culex.	Egg rafts or egg boats.	Do.	Long.	Do.	Do. ditches, cisterns: greater tendency to breathe on ground.	Do.	Do.	Evening	Filariasis.
Anopheles.	Separate, boat shaped, star-shaped pattern.	Float horizontally.	None.	On the surface.	Terrestrial; marshy soil with grass in water.	Angular, awl-like.	Spotted.	Do.	Malaria.

The ova of Anophelines are difficult to detect in nature; but may be seen by the aid of a lens on the margin of small pools where larvæ abound. They are about 0·7 to 1·0 m.m. in size; 50 to 150 eggs are laid at a time. They resemble little boats and have two beautiful oval air cells placed upon each side acting as floats. These floats are very characteristic. Their shape and position differ in the eggs of different species of Anophelines, as do also the width and extent of the beaded rim or frill.

Stephens and Christophers say that it is possible to distinguish the eggs of some species by the position and character of these two structures.

The floats are absent only in two species. They have also got a white frill or a mere ribbed rim around the gunwale of the boat. One end of the ovum is always stouter than the other. The stout end contains the head of the embryo and is the end from which the young larvæ escape. The ova are laid singly without any cement substance, and float singly. In some species star-shaped patterns are seen, whereas in others there is an arrangement in parallel groups. This arrangement is dependent on physical causes. When first laid the ova are white but rapidly darken and become black.

Larvæ.—The larvæ of all mosquitoes can be seen by holding up to light almost any specimen of water that has been left undisturbed for some days, but specially water which contains macerating leaves. They are made up of three regions, *viz.*, the head, thorax and abdomen.

The characters of abdomen afford the readiest means of distinguishing the main groups.

The head of the Anopheles larvæ is more or less rounded in shape. The eyes are situated laterally; in front of each eye is an eminence which carries the antennæ. A broad band of pigment runs across the head between the two eminences from which antennæ arise and this carries six branched hairs which project forward over the head

Arising from the corner of each eminence, and situated just outside the most external of the six hairs is a characteristic hair called the "basal hair." It projects just outside and parallel to the antennæ. It is of value in identification of larvæ of different species.

The anterior median area of the head is called *clypeus* and it carries on each side a large bunch of hairs called the *whorl organs* or *feeding brushes.* Lying directly over each feeding brush is a pair of hairs close together, which are called external frontal hairs and between the feeding brushes of each side is a pair of hairs which are called the median frontal hairs. These four frontal hairs project beyond the head and may be simple or branched. In some larvæ there is a third hair called the *posterior hair* situated just behind and between the two frontal hairs of each side. All these hairs are of service in identification of species.

The *thorax* is broader than the head or than any of the abdominal segments. It carries a number of branched hairs and in some species a pair of palmate hairs (to be described later on) on the abdominal segments.

The abdomen of all mosquito larvæ is divided into nine segments. The first seven segments closely resemble one another. The eighth segment carries the external openings of the respiratory tube, or trachæ, by means of which oxygen is supplied to the tissues of the larvæ. In all Anopheles larvæ the two large trachæ open directly on the upper surface of the eighth segment by two stigmata. The ninth abdominal segment is cylindrical in shape and carries the openings of the anus, around which are symmetrically arranged the four anal papillæ.

Palmate hairs—On the dorsolateral surface of certain of the abdominal segments of *Anopheles* larvæ, *palmate hairs* are present. These hairs are arranged like the leaf of a cocoanut palm. Two of these palmate hairs are present on each segment and it is chiefly by their means that the larvæ maintain their position close under the surface of the water. These hairs are present only in Anopheles larvæ. These palmate hairs actually indent the surface film. When viewed in certain light from one side, these indentations can be plainly seen.

On account of their presence and on account of the absence of a syphon tube, Anopheles larvæ float in the water immediately beneath and parallel to the surface film.

On account of the presence of a syphon tube and the absence of palmate hairs, Culex larvæ float considerably below and at an angle with the surface film.

Movements of larvæ and their method of feeding :—

Anopheles larvæ change their position at the surface of the water by a series of very characteristic jerking, darting movements in a backward direction. When actually occupied in feeding, they lie stationary beneath the surface film, only their mouth parts moving.

Culex larvæ, on the other hand, have no such movement, but when engaged in feeding they are propelled slowly forwards by the action of their mouth parts alone.

Both kinds of larvæ, when disturbed, usually wriggle rapidly to the bottom of the pool, where they lie motionless with their body extended.

Anopheles larvæ feed just beneath the surface film, and whilst feeding, the head is rotated, so that its ventral surface lies uppermost, though the body of the larvæ remains in its original position. This *rotation of the head is peculiar to the larvæ of Anopheles.*

Anopheline larvæ lie flat along the top of the water. One species (*M. turkhudi*) does not, however, rest in this position, but after rising to the surface in a horizontal position slowly sinks until the tail only touches the surface.

Anopheline larvæ which are about to turn into nymphæ also sometimes tend to sink, so that the head is directed obliquely downwards (often seen in *M. rossi*). One species of Culex (*C. concolor*) adopts a nearly horizontal attitude. The palmate hairs are not seen here.

Anopheline larvæ, when full-grown, possess very small heads in proportion to the size of the larvæ. In most of the culicinæ, the head is very large with very prominent and large antennæ.

As Anopheline larvæ grow in size they cast their skin, which is quite perfect and shows chitinous structures and even air tubes.

The bulk of the food of Anopheline larvæ consists of unicellular plants and animals, algæ, etc.

Anopheline larvæ can only resist desiccation at 20° C. for two days, at 35° C. for one day, and 40° C. for two minutes only (Celli and Casagrand).

Larvæ of Anophelines stranded on moist mud will live as long as four days, but in the tropics as soon as the mud loses its glistening surface they die (Stephens and Christophers).

Some large Culex larvæ devour Anopheline larvæ and small Culex larvæ. Culex concolor and Culex tigripes are specially cannibalistic.

The enemies of Anopheline larvæ are small fish, water beetles and other water animals. There are two special kinds of fish which devour mosquito larvæ. One variety is *Haplochilus lineolatus* and is known locally as "*piku.*" It can be distinguished by the presence of an elongated ray in the ventral fin and by its colour, which is greenish above with a purple tinge on the abdomen. Eight to ten vertical bands pass across the sides and each scale has a golden green spot in the centre. It has also got a white spot on the top of the head. The other variety is *Anabas scandens* and is known locally as "*Kazara*" or "*Khajura.*" It can be distinguished by the following particulars :—The body is rifle green above, becoming lighter on the abdomen, and during life there are usually four white vertical bands and a dark stripe from the angle of the mouth to the margin of the preoperculum. The back of the head is dull red as also are the ventral fins, and the roots of the pectoral and anal fins are tinged with the same colour. There is a black blotch on the side of the base of the tail and usually a black spot is also present on the posterior margin of the operculum. As regards the area of surface that can be kept free from larvæ by *Haplochilus*, three of these fish are sufficient to prevent any larvæ developing in a small aquarium having a surface area of 1′-6″ by 2′-6″ (Sewell and Chaudhuri). Turtles, tadpoles, etc., do not destroy larvæ. Weeds often protect larvæ from being consumed by small fish. Oils rapidly kill larvæ by blocking the air tubes. Pools covered with duckweed (Lemna) are very frequently free from larvæ. The action of Lemna is said to be mechanical. Wherever possible, duckweeds should be grown in ponds, tanks, etc. (Stephens and Christophers).

The structures by which the larvæ of *different species of Anopheles* may be identified are as follows:—

(1) The external and median frontal hairs.

(2) The *palmate hairs.*—Each hair consists of a short stalk surmounted by a bundle of about 15 to 18 hairs arranged round the stalk like the petals of a flower. When the larva comes to the surface, these leaflets spread out and form a series of little cup-shaped organs, which serve to keep the larva floating in the horizontal position. The number and shape of these hairs vary in different species.

(3) The *antennæ.*—The size and position of the antennal tuft or tufts are of systematic importance. In Stegomyia the antennæ are small and spineless and possess a single hair about the middle. In Culex concolor the antennæ are peculiar. In the majority of larvæ, a very small hair on the outer side of the antennæ is seen. In two Indian species stout branching hair on the inner side of each antenna is seen.

(4) The *pattern of the head markings.*—The inverted triangular area enclosing four dots of pigment on the dorsal surface of the head of the larvæ of Anopheles rossi is very characteristic.

(5) The *basal hair.*—The posterior hair is in some species branched and in others unbranched.

The pupæ or nymphæ are extremely characteristic bulbous comma-shaped creatures, having a large globular body and a small tail kept more or less tucked in beneath. When disturbed they dart downwards with great speed. They sink in water only by violent exertions of their tails. As soon as these movements of the tail cease, the buoyant pupæ float up to the surface again. They breathe through two protruding spiracles or air tubes, which are situated on the dorsum of the thorax as two trumpet-shaped structures projecting like horns.

Anopheles pupæ have short, stumpy funnel-shaped spiracles, while those of Culex are longer, more slender and trumpetshaped.

The adult mosquito or imago.—It is divided into three regions, *viz.*, the head, the thorax and the abdomen. To the head are attached sensory and suctorial appendages and to the thorax are attached the legs and wings.

Head :—There are two large compound eyes. These meet below and approach one another very closely above. The following are the usual names for the different regions of the head :—

(1) The nape—the extreme back of the head.
(2) The occiput—the position behind the eyes.
(3) The vertex—the space between the eyes.
(4) The frons—the space in front of the eyes.
(5) The gena—the side of the head below the eyes.

The frons is triangular in shape, with one angle directed downwards. The antennæ rise from the two upper angles of the frons, and from the lower projects the clypeus lying over the base of the proboscis.

The *clypeus* projects over the base of the proboscis as a prolongation of the frons.

The *antenna* consists of 14 to 16 segments, of which the basal one is large and globular. In the male it is plumose whereas in the female it is pilose.

The proboscis.—The *proboscis* consists of the very highly specialized mouth parts ensheathed in the lower lip or labium. It consists of—

(1) The *labium*—forming the sheath. It forms the thick and scaly proboscis. On its dorsal surface it is hollowed out and in this hollow run as in a sheath the piercing mouth parts or stylets. The labium itself does not penetrate the skin, but becomes sharply bent during the act of biting, just as a cane walking stick when pushed against the ground.

(2) The *labella.*—Attached to the end of the labium by a hinged joint on either side are two leaf-like processes, the labella. It is through the angle made by the two labella that the stylets pass, as a billiard cue between the first and second fingers. The labium proper stops short at the point of junction of the labella, but is continued on its upper surface as a blunt point covered with fine hairs. The area between the end of the labium proper and the extreme tip is covered by an extremely thin membrane called *Dutton's membrane.* In the act of biting, when the labella are separated, this membrane is somewhat stretched and applied to the skin.

According to the late Dr. Dutton of the Liverpool School of Tropical Medicine, the *filarial embryo* really lies in the tissue of the fleshy labium, and it is by the rupture of this excessively thin membrane that the embryo escapes.

(3) The stylets consisting of—
  (*a*) the labrum and epipharynx or upper lip ;
  (*b*) the hypopharynx ;
  (*c*) two mandibles ;
  (*d*) two maxillæ.

(1) The *epipharynx* is the central tube through which the blood is sucked. Its point slopes off like the tip of a hypodermic needle.

(5) The *hypopharynx* is a thin, flat two-edged lamella closely applied to the undersurface of the epipharynx. It is pierced by the salivary duct down which the salivary secretion and sporozoites pass.

(6) The *mandibles* are very fine chitinous rods, in cross section, crescentic in shape. There are about 30 serrations at the tips.

(7) The *maxillæ* are stouter than the mandibles. They have about 12 serrations at the extremity.

(8) The *maxillary* palps.—These lie upon either side, and somewhat dorsally to the proboscis. They take no part in the act of biting.

Thorax.—The main portion of the thorax is *mesothorax.* Anteriorly there is a collar-like piece of chitin, called the prothorax.

Mesothorax.—The *scutum* of the mesothorax forms the large globular mass of the thorax. Behind the scutum is a transverse bar of chitin called scutellum. Behind the scutellum is a convex triangular area called the *post scutellum.*

Abdomen.—The *abdomen* consists of nine segments. The anus opens on the ventral surface of the eighth segment. To the ninth segment are attached the genitaliæ. The genitaliæ are lobed appendages. In the male they are provided at their free end with claspers. These claspers are of specific value.

The *Wings* consist of—

(1) an anterior straight, thick and strong border or *costæ* ;

(2) a posterior curved and thin border carrying a *fringe* ;

(3) nervenres or veins.

The *costæ* in Anophelines are generally covered in part with white and in part with black scales, forming the *spotted margin.*

The *fringe* in Anophelines has light and darker portions the number and position of which are of importance.

The *nervenres.*—The relative position of the apices of the two forked cells is of importance. There are six longitudinal veins of which the second, fourth and fifth are branched and the others unbranched.

Legs.—They consist of the following segments :—

(1) Coxa.
(2) Trochanter } (small pieces at the origin of the legs).
(3) Femur.
(4) Tibia.
(5) Tarsus, consisting of 5 segments the last of which carries the claws or ungues. The ungues vary. They may be simple, uniserrated or biserrated. They are of specific value. The first tarsal segment is sometimes called *meta-tarsus.*

To determine the genus.—The scales on the wings and on the body are distinctive of mosquitoes, and from the character of these scales the genera can be made out.

On the wings.—Flat scales occur in a double row along each vein and there are also lateral rows.

On the legs.—Nearly always flat.

On the head.—Narrow-curved, upright, forked, flat and occasionally spindle-shaped.

On the thorax.—Hair-like, narrow-curved, spindle-shaped and flat.

On the abdomen.—Hair-like, spindle-shaped and narrow-curved.

The points which serve to *distinguish the Anopheline from other groups of mosquitoes are* —

(1) The *relative length of the palpus and proboscis.*—The palpi, in the male in both Culicinæ and Anophelinæ are long structures as long as and longer than the proboscis. In Anophelinæ it is *clubshaped* or *cleavate, and in Culicinæ* it is *acuminate.* In the *female Culicinæ* the palps are quite short and insignificant structures, whereas in the female Anopheline these are scaled and as long as the proboscis.

(2) The *wings* in most species of Anophelines are spotted. This spotting is due to the presence of areas of dark scales upon the wing veins, elsewhere covered with light scales. As a general rule, mosquitoes with spotted wings are Anophelines.

(3) The *angle which the proboscis makes with the rest of the body* is very different in Anophelines from that in other mosquitoes. In Culex or Stegomyia the proboscis forms a distant angle with the line of the body. In the case of Anophelines the proboscis continues in the line of the body (*A. stephensi*, fifteen degrees). Thus an Anopheline mosquito has a peculiar awl-like appearance.

(4) The *attitude adopted by Anophelines* is quite characteristic. When an Anopheline rests upon a wall, its body projects so as to form a distant angle with it. In some cases the angle assumed is almost a right angle. In the case of almost all other mosquitoes the body is held either *parallel with the wall* or, what is more frequent, the tail approaches the wall giving the insect a *hunch-backed appearance*. Anophelines rest by preference on the first two pairs of legs only, and keep the last pair stretched out stiff and straight, or they slowly oscillate to and fro.

In Bombay the following seven varieties of Anopheline mosquitoes are found :—

(1) Nysso-myzomyia rossi.
(2) Neocellia stephensi.
(3) Myzorhynchus barbirostris.
(4) Nyssorhynchus jamesi.
(5) Nyssorhynchus fuliginosus.
(6) Myzomyia listoni.
(7) Myzomyia culcifacies.

The following are the distinguishing characters of these different varieties in the larval and adult stages :—

LARVAL STAGE.

Varieties of Anophelines.	Head.	Frontal Hairs.	Palmate Hairs.
Nysso-myzomyia rossi	Pattern on the head.	Internal, long. External, short. *No lateral branching.*	Leaf tapered and extended into a long filament.
Neocellia stephensi	....	*Fine lateral branches.*	Leaf not tapered, but short and blunt or rather rough and broken-looking.
Myzorhynchus barbirostris ...	*Antennæ* of larvæ have a *branched hair on the inner surface.*	Internal, very long and unbranched and often *cross over at tip.* External, thickly branched and resemble *cockades.*	Leaf large, coarsely tapered, and not extended into a filament. Palmate hair *present on thorax.*
Nyssorhynchus jamesi	....	Both internal and external have a large number of fine lateral branches.	Very large broken-looking and slightly pigmented tops and a mediumly long filament.
Nyssorhynchus fuliginosus ...	....	Do. do.	Do. do. ...
Myzomyia listoni	Larvæ of these two are indistinguishable from each other.	Fine lateral branches like N. stephensi (Bentley). Simple and unbranched (Liston).	Leaf large and prominent. Shoulder serrated and pigmented. Filament short. *Palmate hair present also on thorax (very large.)*
Myzomyia culcifacies ...		Internal, short, and have one or two lateral branches. External, slightly branched.	Leaf large and prominent. End broad and broken-looking. Filament of medium length but longer than that of listoni. *Palmate hair present also on thorax.*

ADULT STAGE.

Varieties of Anophelines.	Palpi.	Legs.	Remarks.
Nysso-myzomyia rossi ...	One white broad band at the tip and two narrow ones lower down.	*Uniformly black.* Tarsal joints banded. *Femora and tibia not speckled.*	No scales on the abdomen. Wings spotted with black.
Neocellia stephensi ...	Two white broad bands above and one narrow lower down.	White specklings of legs. Femora and tibia *speckled.*	Scales on abdomen.
Myzorhynchus barbirostris.	Thick, black and unbanded.	Uniformly black. None of the tarsal segments is white in its whole length.	*Mosquito in mourning.*
Nyssorynchus jamesi ...	Three white bands, one broad at tip and two lower down.	Last three segments of hind tarsus are *entirely white. Femora and tibia speckled.*	*Lady in white stockings. Waving its hind* legs in the air when at rest.
Nyssorhynchus fuliginosus.	White bands.	Last three segments of hind tarsus are *entirely white.* Femora and tibia *not speckled.*	
Myzomyia listoni ...	Three white bands..	Brown throughout and always *without* the little patch of light scales at the apical end of the tibia.	*First fork cell of the* wing is more than 1½ times the length of the 2nd fork cell. *Five pale areas* on the wing fringe. The third longitudinal vein is white-scaled except at its origin and termination and hence distinguished from the following.
Myzomyia culcifacies ...	Three bands, one at tip and two lower down.	Dark-brown throughout, but always *with* a tiny spot of yellow scales at the apical end of the tibia.	*Marked Culicinæ attitude* when at rest; *first fork cell* is less than 1½ times the length of the second fork cell; *wing fringe* has two white areas. No scales on abdomen. The third longitudinal vein is dark scaled almost throughout.

The normal distance of flight of Anopheles does not exceed half a mile. Anopheles feed almost exclusively at night or in the early morning. As a rule, they are strictly nocturnal in their habits. During daytime they are found in the darkest corners of rooms. They seldom or never rest upon light coloured clothes or on cleanly whitewashed walls.

Mode of dispersal.—The accidental modes of dispersal are as under:—

1. In trains, boats and even in ocean-going steamers they may be carried long distances.
2. Locally, streams and canals.
3. Wind. Nearly all the excessive distances refer to Culicinæ. Anophelines dislike wind and seek shelter from it.
4. Trees, plantations, bush, jungle. These hinder the flight of Anophelines.

The food of Anopheles larvæ consists of minute water animals. The duration of the larvæ stage depends upon the supply of animal foods. Sometimes the stronger larvæ kill and eat the weaker.

In the absence of more suitable breeding places, Anopheles will lay their eggs in almost any collection of water in nature.

Mosquitoes are found to prefer negroes to whites, a black dog to a white one, and a dark coloured resting place. Careful tests have been extended to great numbers of the insects showing that they choose colours in the order of dark-blue, dark-red, brown, red, black, grey, and violet, and that azure, ochre and white are distasteful and yellow extremely so. Confirming these results on 150 mosquitoes, a Swiss Malaria expert has found that three-quarters settle on dark colours.

Anophelines as well as Culicines have a predilection for certain smells. Old boots and blacking attract them strongly and the leather of a saddle room is their favourite haunt.

The length of life of mosquitoes is several weeks to months.

PLANTATIONS AND MOSQUITOES. (Rubert Boyce).

(1) *Tobacco Plantations.*—Here drainage operations are very carefully undertaken, for it has been found that the finest kinds of tobacco could only be grown as the result of very careful drainage and the suitable drying of the soils ; in consequence the swamps disappear and the place remains free from Malaria.

(2) *Cocoa Plantations.*—The soil should be thoroughly drained and the plantations intersected by very numerous drainage channels, leaving from the high ground to a main channel as the lowest part of the estate. Thus water never puddles or remains stagnant. Careful cultivation including drainage leads both to the increased production of crops and to a diminution of cases of Malaria.

(3) *Sugarcane Fields* should be intersected by numerous trenches and canals ; the Anophelines are kept down by the presence of fish and by flushing.

(4) *Rice Fields* although for the most part remain submerged, small fish keep in check the production of the Anophelines.

(5) *Grape-vine Planting.*—Careful drainage is necessary to diminish Malaria.

PREVENTION OF MALARIA.

Personal—

(1) Malarious and marshy places should be avoided.

(2) Mosquito nets without holes should be fixed inside the poles and tucked under the mattress.

(3) Windows should be protected with wire gauze.

(4) *Punkhas* and electric fans drive away mosquitoes.

(5) Quinine should be taken regularly every day before breakfast.

(6) Boots, etc. (dress).

(7) Segregation (from native quarters).

It is extremely dangerous to sleep in a house which is occupied, or has recently been occupied, by infected persons, especially native children; or in or close to an infected native village.

Public—

(1) Public instruction (lectures, placards, etc.)

(2) Segregation.

(3) Isolation (*a*) of the sick, (*b*) of the healthy from Anopheline bite. All public buildings should be screened, *e.g.*, Hospitals, Jails, Asylums, Railway Stations, Hotels, etc.

(4) Quinine should be administered to the sick and the healthy.

(5) Mosquito reduction, major and minor works.

(6) Measurement of Malaria parasite rate and spleen rate.

Preventive Measures for Mosquito Reduction.

Malaria will not remain in a locality (1) unless the carrying agents (Anophelines) are numerous enough; (2) unless there are enough infected persons to infect the carriers; and (3) if the insects are prevented from biting human beings. There are thus three groups of preventive measures which may be employed by public authorities to reduce the disease, *viz*:—

(1) Anopheline reduction.
(2) Case reduction.
(3) Isolation.

Drainage of the soil, as applied to Malaria, means Anopheline reduction.

Case reduction—by quinine.

Isolation or protection from bites of mosquitoes by mosquito nets.

Thus an anti-Malaria campaign consists in drainage, the clearing of jungle, the "training" of the *nullas, i.e.*, rendering them so smooth and even that the Anopheline could no longer breed in them, the use of wire gauze, oiling the pools, and quinine prophylaxis.

General isolation from mosquito bites is attempted by the use of (*a*) Culcifuges, (*b*) clothing, (*c*) mosquito nets, and (*d*) screens to the windows.

(*a*) Culcifuges are medicaments such as pesterine, kerosine oil, lavender oil, etc., for keeping away the insects.

For fumigation the best disinfectants are the following :—

(1) Sulphur —2 lbs. to 1,000 cubic feet for 3 hours.

(2) Pyrethrum —3 lbs. to 1,000 cubic feet for 3 hours.

(3) Camphor and carbolic acid in equal parts are fused together into a liquid by gentle heat ; 4 ozs. of the mixture are vaporized to each 1,000 cubic feet for 2 hours.

(*b*) Clothing, gloves, veils, boots, etc.

(*c*) Mosquito nets—very important.

(*d*) Mosquito—proof screens.

Minor works for Mosquito Reduction.

(1) Sufficient workmen should be employed in towns and villages to do and maintain the minor works, *viz.* :—

(*a*) Keeping street gutters and surface drains clear of weeds and other obstructions.

(*b*) Clearing of weeds, levelling and discharging road-side ditches and channels.

(*c*) Keeping made-water channels clear of weeds and pools.

(*d*) Removing grass, weeds and pools from the margin of ponds and streams and rough canalization of the latter.

(*e*) Discharging, filling or deepening surface pools where practicable.

(*f*) Discharging leakage from stand-pipes.

(*g*) Filling or oiling certain pits.

(*h*) Concreting hollows in rocks and holes in trees.

(*i*) Cutting undergrowth.

(2) A number of men called *moustiquiers* should be engaged to detect the breeding places of mosquitoes.

(3) An officer to be called the Malaria Authority should be appointed to superintend the works.

(4) Legislation for facilitating the works should be undertaken.

Major Works for Mosquito Reduction.

For draining, deepening, or filling marshes, or for canalising streams, etc., work should be undertaken when funds allow.

Mosquito Trap.

Prof. Howlett of the Agricultural Research Institute, Pusa, Bengal, gives the following instructions for making a Mosquito Trap:—

"The box is an ordinary wooden box or packing case the inside either painted black or (preferably) lined with dark or black cloth, except on the floor side, which is covered with a sheet of tin. One side of the box forms a sliding or hinged door, and there is a small hole in the top, which is closed by a cork.

"The box should be long enough from front to back to make the inside quite shady and out of the light. The dimensions of the box are unimportant, say 18 inches to 2 ft. long by 9 in. to 1 ft. square (*i.e.*, height and breadth). In use the box is put in a room or elsewhere with the door wide open. Between 12 and 3 o'clock the door should be quickly shut to imprison the mosquitoes inside which have been attracted by the shadow, and a small tea-spoonful of benzene or petrol should be poured through the small hole in the top of the box, which is then immediately corked up again. In ten minutes, or a quarter of an hour, the door is opened, the dead mosquitoes removed, and the box is then left open until the following day, when the door is again shut at some time between 12 and 3, the benzene poured in and the dead mosquitoes taken out."

Professor Simpson, speaking before the London Chamber of Commerce on " Malaria and its Prevention," said that ' No mosquitoes, no Malaria ' should be placarded in every school, public building, church, temple and other places of assembly in malarious countries. " The children should be taught to recognise the larvæ and the method of destroying them. If boy and girl scouts in every village and town hunted forth and reported where the larval enemy was found, many malarious localities could soon be cleared."

MALARIA PREVENTION IN BOMBAY.

Organisation and Methods of work :—

In Bombay a special Malaria Department exists under the supervision of the Executive Health Officer and under the control of a Special Malaria Assistant. The staff provided under him consists of four Inspectors, on a salary of Rs. 125 to 150 , who are all fully qualified medical men, two of whom hold the degree of Bachelor of Hygiene and a third has studied in the London Tropical School ; 38 Sub-Inspectors, 20 on Rs. 40 and 18 on Rs. 35, and 81 bigaris on Rs. 11 each.

The Special Assistant has been provided with a separate office and five clerks and one Laboratory Assistant.

A Laboratory has also been provided with two microscopes, two dissecting microscopes and other necessary appliances.

The four Inspectors and one Sanitary Inspector supervise the work of the Sub-Inspectors and their offices are in the Municipal Charitable Dispensary buildings.

The Sub-Inspectors have been distributed in such a way that each house can be revisited every 7 to 15 days according to the importance of the locality.

The implements required for Malaria work are:—

1 Ring-net with rope, 1 *Zarec*, 1 Hand-net, 1 Tin hand-pump, 1 Enamel cup, 1 Enamel spoon, 1 Enamel pan, 1 Bucket with rope and 1 Ladder, in addition to empty Quinine bottles and Winchester Quarts for sending samples of larvæ and water.

For each and every house in A, B, C, D, and E Wards there is a card showing wells, cisterns, tanks, etc., and the variety of larvæ found, if any. Cards are also prepared for those houses where there are no potential sources of mosquito breeding. This is necessary, so that during the subsequent inspections if any larvæ are found the fact can be entered there.

The procedure is for the Sub-Inspector to fill in a card for each and every house in his beat, entering therein whether any larvæ were found and of what variety. This card is then sent to the office, when a letter is written to the party to hermetically cover the well or cistern, as the case may be. If this is not complied with, a reminder is sent after 15 days and, if nothing further is done, the water in case of wells is sent to the Municipal Analyst for chemical analysis and the well is then reported to the Municipal Commissioner for obtaining the sanction of the Standing Committee under the amended Section 381 of the Municipal Act. Subsequent visits of the Sub-Inspectors are entered at the back of the card so that it can be easily ascertained after how many days a particular house was re-visited.

In addition to the cards, there is also a Mosquito Record Book or a Mosquito Street Register, which shows at a glance the mosquito record for each and every house in the City.

Spot maps are kept in each Ward and also in the office, showing the position of the wells, cisterns, etc., breeding larvæ either of Culex or Anopheles mosquitoes (the Culex in black ink and Anopheles in red ink). The different varieties of Anopheles larvæ are also shown on the spot maps.

Action is taken both for Anopheles of all varieties and for Culex mosquitoes.

A list of places where mosquitoes were found is published weekly in the press and postcards with particular instructions are sent to every house where larvæ were found.

Blood examination.—Although Spleen Census gives valuable information regarding antecedent Malaria and may be used as a measure of malarial endemicity, the microscopic examination of the blood gives information regarding the actual presence of infection and the species of parasites.

The system of "Random Sampling" is adopted for this purpose. A new copper pice is given to a child for having his or her finger pricked and this inducement is found to succeed well in obtaining blood specimens of children. Blood films are collected in this manner from localities in different parts of the City.

Measurement of Malaria.

The most valuable means of measuring the amount of Malaria in a locality is the estimation of—

(1) Spleen Index, (2) Parasite Index, and (3) Mortality from Malaria.

Spleen Index.—Examining the spleen is now a routine method of measuring Malaria in a community. Such a census is taken among young children only, because observations made upon persons of different ages resident in Malarial countries show that, after a certain age, splenic enlargement becomes much less common owing probably to the occurrence of a condition of toleration or partial immunity produced by long exposure to infection. The Spleen Census is the simplest and an accurate method for estimating the amount of Malaria amongst a large population.

In addition to the Spleen Census, the District Registrars keep a record of those patients (under 16 years) attending their dispensaries who have enlarged spleen.

Wells.

As regards wells, a great deal of difficulty is experienced owing to religious objections raised by the public, especially Parsis and Hindus. In order not to wound the religious susceptibilities of these communities, trap doors over wells are allowed on the distinct understanding that they should be kept under lock and key and opened only when water is actually being drawn out. Wells which are close to privies and contain water polluted with sewage are ordered to be filled in.

Trap doors are allowed only in cases where there are strong genuine religious objections and that too after personal enquiries either by the Municipal Commissioner or the Health Officer or his Assistant.

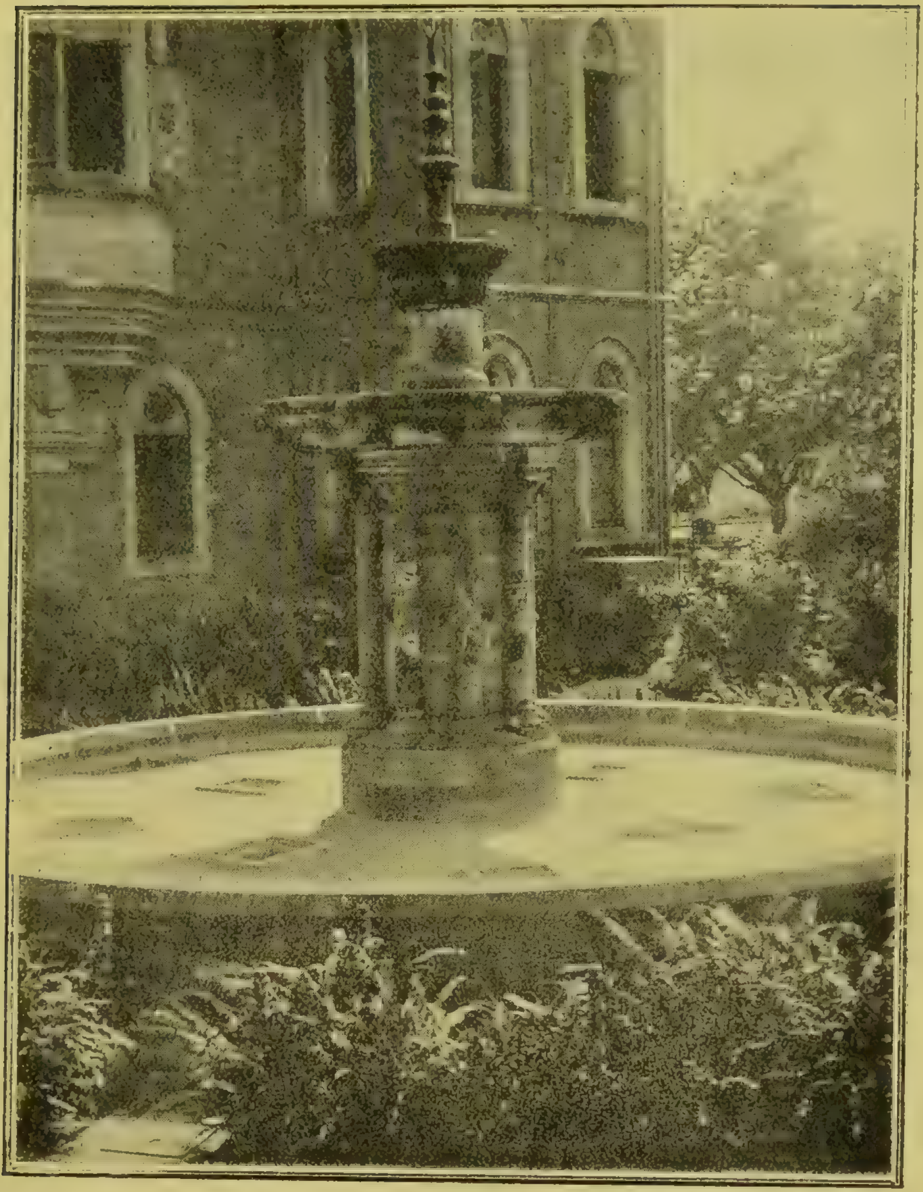
The covering approved by the Department is of two kinds, as shown in the accompanying photographs.

(1) One kind of cover is made of wire gauze of 20 meshes to a running inch, and covered over on the top with expanded metal so that the gauze underneath may be protected. With this sort of cover, a trap door under lock and key or a hand pump is allowed if the water is required for religious observances, washing and similar purposes. These covers cannot last long on wells in open compounds, as the gauze is likely to break in the monsoon with the force of the rain and is likely to rust.

(2) To obviate this difficulty, there is another variety of cover in which the whole surface of the well is covered over with brick, &c., and cement, leaving a small opening of 1½ to 2 square feet which is covered over with trap door either of wire gauze or wood. These trap doors are allowed under one condition, *viz.*, that they should be kept under lock and key and opened only when water is actually being drawn out.

Persons who hold very strong religious objections prefer wire gauze covers, as they say sun-light must play on the well water.

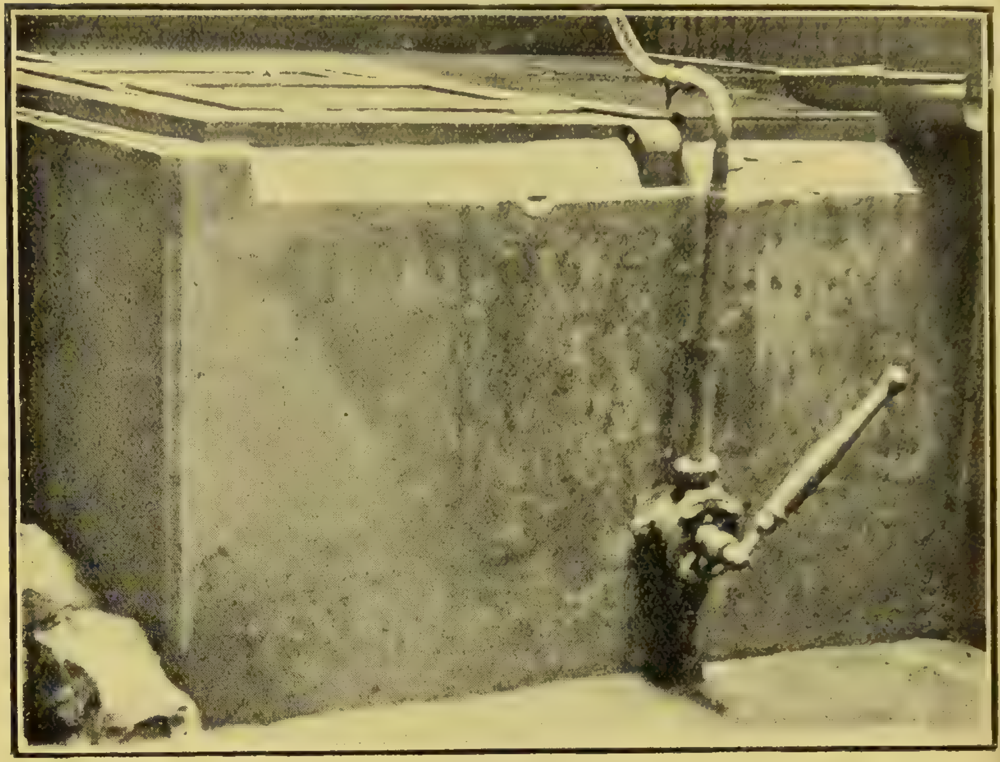
Before enforcing hermetical covering over wells, a trial is given to *Khajura* fish. In many cases this fails, as the wells are not kept free from leaves and other shrubs.



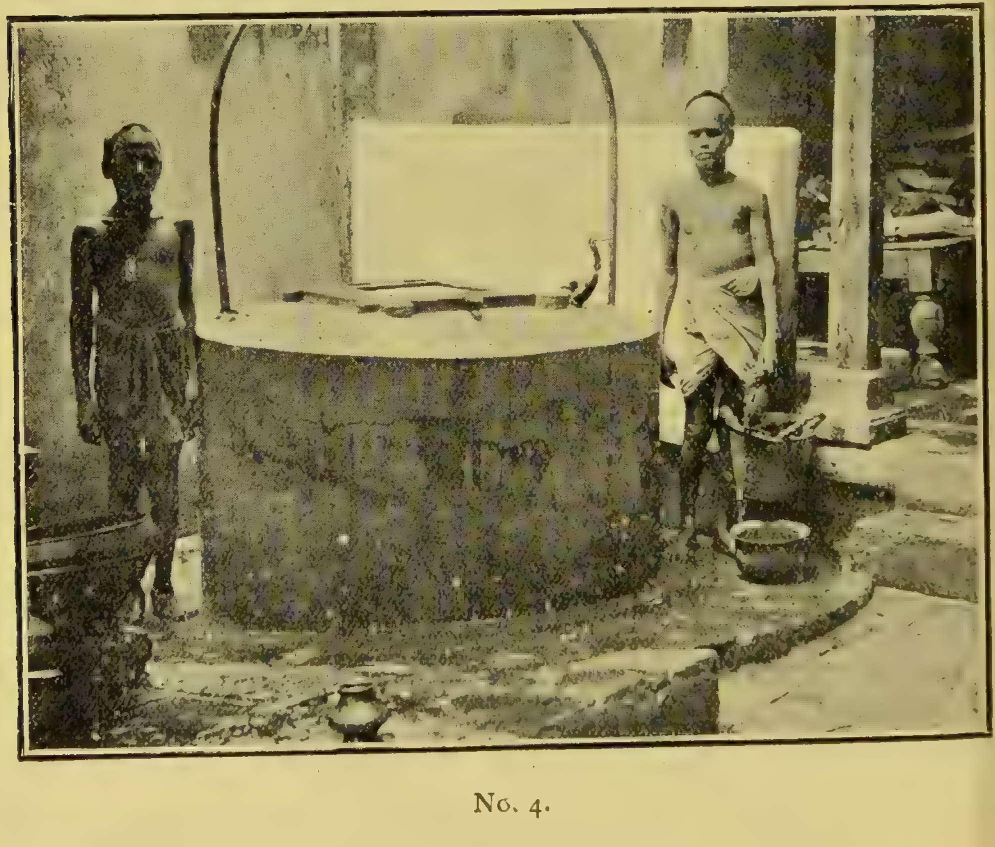
No. 2.

As the fountain in the Head Municipal Office continued breeding larvæ of Anopheles mosquitoes, it was covered over with reinforced concrete, leaving small openings protected by wire gauze. Illustration No. 2 shows this fountain so protected.

Of the coverings over wells enforced by the Department, two illustrations (Nos. 3 & 4) are given, one showing full wire gauze cover protected by expanded metal with a trap door under lock and key and a hand pump. The hand pump is for ordinary domestic use and the trap door is to be opened only when the water is required for religious purposes.



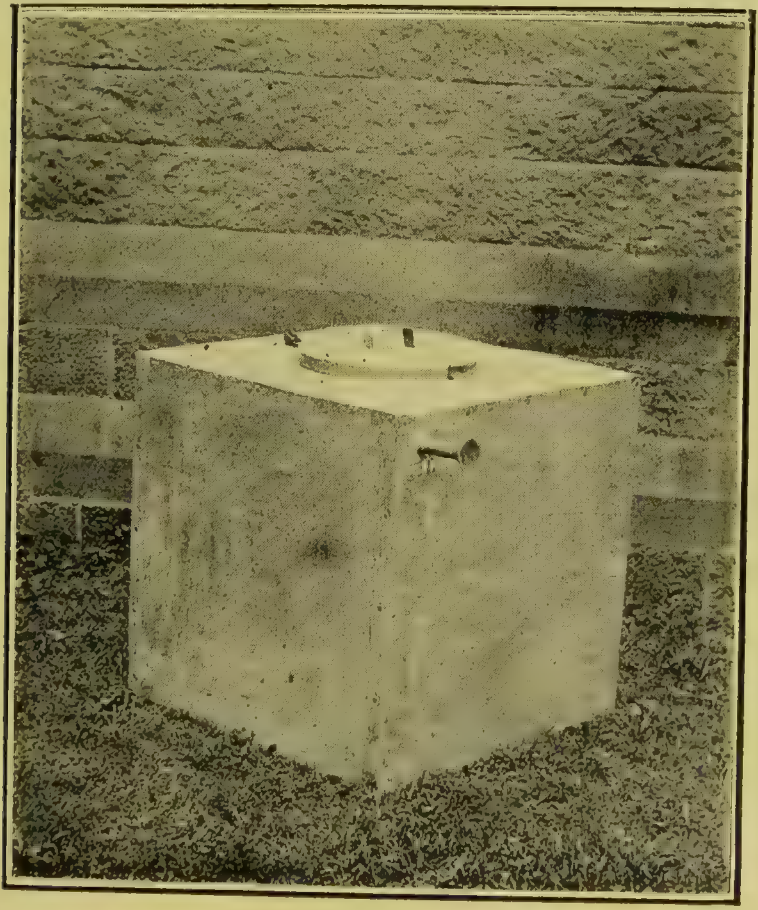
No. 3.



No. 4.

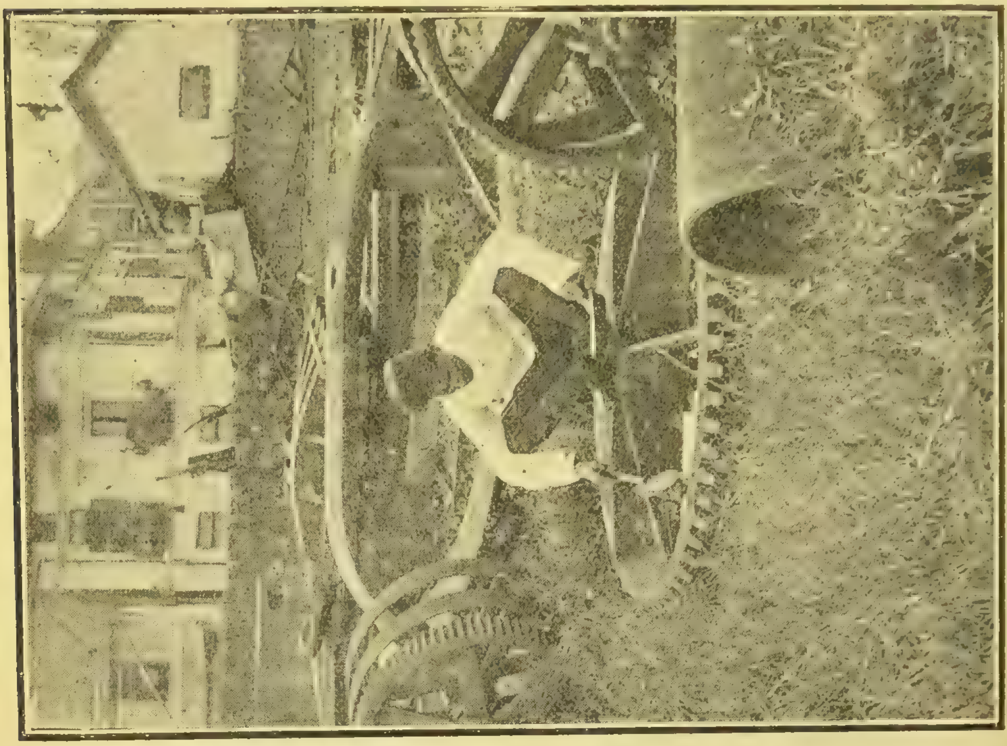
The second cover is made of concrete and cement with a trap door $1\frac{1}{2}$ to 2 square feet in area made of wire gauze and kept under lock and key and to be opened only when water is actually being drawn out. This cover is more lasting than the first, as in the former case the gauze is likely to rust and get non-mosquito-proof soon. The meshes of wire gauze enforced are 20 meshes to a running inch. As stated above, trap doors are allowed only when there are genuine religious objections. When there are no such objections, wells are hermetically covered either with reinforced concrete, wood, or bricked or arched over. Hand pumps are insisted upon in such cases.

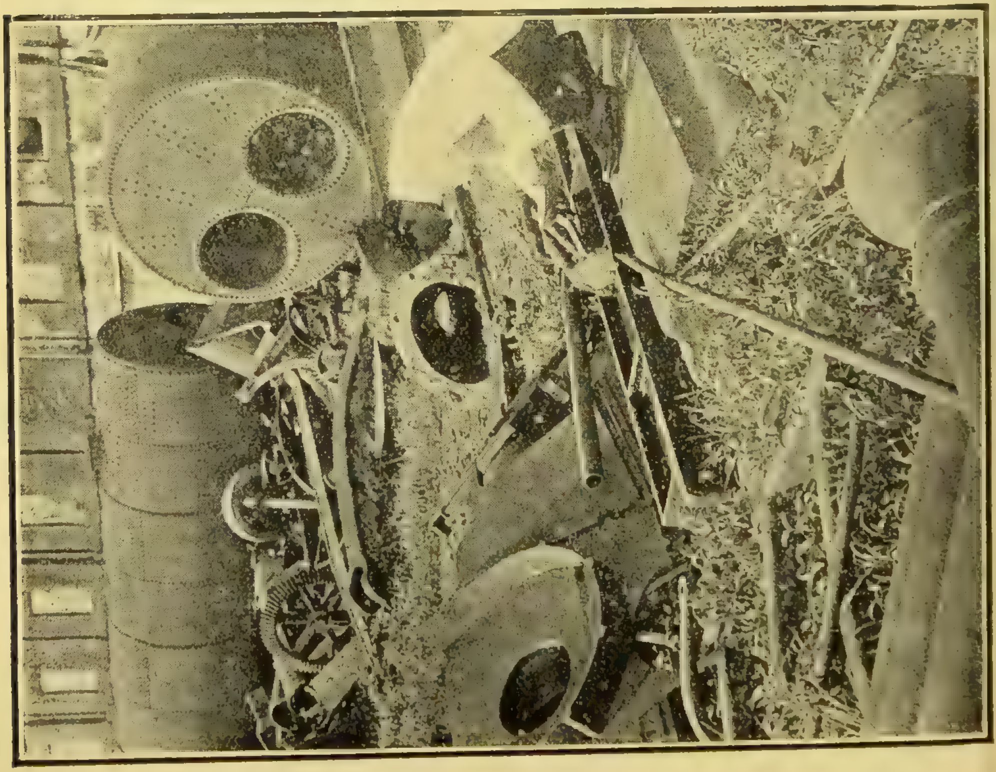
Illustration No. 5 shows the model of a cistern with a mosquito-proof cover under lock and key and the warning pipe protected by wire gauze.



No. 5.

Illustrations Nos. 6, 7 and 8 show the nature of the breeding places of mosquito larvæ. Nos. 6 and 7 show the hollows in the heavy machinery of a press that was burnt down some years ago. Rain-water collects in these hollows in the rainy season and these continue to act as breeding places.





No. 8.

Illustration No. 9 shows the typical breeding places of Stegomyia larvæ. These tubs, full of water, are kept in fuel wood depôts, according to the conditions of the license, but being kept open and unprotected, the water is found teeming with these larvæ.

No. 9

Illustration No. 10 shows breeding places in parched rice factories, where water is stored for use.

No. 10

Illustration No. 11 shows larvæ found in *Dhobies'* tubs where water is never changed for days together.

No. 11

The Legal Aspect of Mosquito Prevention.

The only Section under which action can be taken is Section 381 of the Bombay Municipal Act. Under this Section action could formerly be taken against wells, tanks, pools, low grounds, etc., and only with the sanction of the Standing Committee ; but not against open or non-mosquito-proof cisterns and other receptacles which breed larvæ. Nor could action formerly be taken under any section of the Act for allowing breeding places in any premises so as to result in nuisance. To remedy this the Act was recently amended and the amendments are as follows :—

For Section 381 of the said Act the following shall be substituted :—

"381. (1) If in the opinion of the Commissioner—

(*a*) any pool, ditch, tank, well, pond, quarry-hole drain, water-course, or any collection of water, or (*b*) any cistern or other receptacle for water whether within or outside a building, or

(*c*) any land on which water accumulates and which is situate within a distance of one hundred yards from any building used as a dwelling house,

is or is likely to become a breeding place of mosquitoes or in any other respect a nuisance, the Commissioner may, by notice in writing, require the owner thereof to fill up, cover over or drain off the same in such manner and with such materials as the Commissioner shall prescribe, or to carry out such order for removing or abating the nuisance as the Commissioner shall issue.

(2) If an owner, on whom a requisition is made under sub-section (1) to fill up, cover over or drain off a well, delivers to the Commissioner, within the time prescribed for compliance therewith, written objections to such requisition, the Commissioner shall report such objections to the Standing Committee and shall make further inquiry into the case, and he shall not institute any prosecution under Section 517 for failure to comply with such requisition except with the approval of the Standing Committee, but the Commissioner may nevertheless, if he deems the execution of the work called for by such requisition to be of urgent importance, proceed in accordance with Section 489 and, pending the Standing Committee's disposal of the question whether the said well shall be permanently filled up, covered over or otherwise dealt with, may cause such well to be securely covered over, so as to prevent the ingress of mosquitoes, and in every such case the Commissioner shall determine, with the approval of the Standing Committee, whether the expenses of any work already done as aforesaid shall be paid by such owner, or by the Commissioner out of the Municipal Fund or shall be shared, and, if so, in what proportions."

After Section 381 of the said Act the following shall be inserted :—

" 381A. (1) No new well, tank, pond, cistern or fountain shall be dug or constructed without the previous permission in writing of the Commissioner.

(2) If any such work is begun or completed without such permission, the Commissioner may either—

(*a*) by written notice require the owner or other person who has done such work to fill up or demolish such work in such manner as the Commissioner shall prescribe, or

(*b*) grant written permission to retain such work, but such permission shall not exempt such owner from proceedings for contravening the provisions of sub-section (1)."

Water Connection Rules :—Rule 36 of the new Water Connection rules states that "all cisterns shall be properly covered with a close fitting *dust-tight* lid, &c." Although in many cases such lids are provided, the servants tamper with the covers and generally leave the cisterns open, thus affording facilities for the breeding of mosquitoes. The Municipal Commissioner at the request of the Health Department, in consultation with the Hydraulic Engineer, has therefore decided to amend the rules and to keep a model cistern for the guidance of plumbers :—

Rule 36.—The words "fitted with an approved lock and key" may be inserted after "*dust-tight* lid" in line 6.

Rule 40.—The words "and mosquito-proof" may be inserted after "efficient" in line 2.

The rules as amended will run as under :—

"36. Every existing cistern, if not sound or efficient or is such as causes waste or is such as cannot be efficiently repaired, or every future cistern, reservoir or storage tank shall be of the prescribed kind and shall at all times be made and at all times maintained water-tight, shall be properly covered with close fitting, dust-tight lid fitted with an approved lock and key and shall be provided with a sound and suitable ball-cock of the prescribed kind securely fixed to the cistern independently of the supply pipe and so set that the ball will not become submerged when the level of the water in the cistern is below the warning pipe or allow the water to rise within two inches of the lower side of the overflow or warning pipe. A stop-cock shall be provided on the outlet pipe of all cisterns and fixed as near the cistern as possible."

"39. Every cistern, reservoir or storage tank hereafter used or fixed in connection with water supplied by the Corporation must be accessible and placed in such position as to admit of thorough inspection and cleaning, and if placed within the house or building shall have a clear space of not less than two feet between its top and any ceiling, rafter or roof. No cistern. reservoir or storage tank, except those supplying closets, latrines and urinals only shall be fixed in any water-closet, latrine or urinal or in any place in which injurious gases are likely to be produced, and as far as practicable shall not be placed immediately over any water-closet, latrine or urinal."

It has to be remembered in connection with Malaria measures in Bombay that a large number of persons of the labouring classes come to the City daily from the surrounding infected countries. These persons act as "reservoirs" and in suitable surroundings act as propagators of the disease through the agency of Anopheline mosquitoes.

Instruction to the Public.

In order to enlighten the public on this important question, the Bombay Malaria Department has been giving lectures and demonstrations with the help of the following magic lantern slides. :—

1. Egg raft and eggs of Culex—

   Raft boat-shaped, about 200 eggs in each; ova smooth, elongated, no floats, one end thicker and blunter; to the thicker end is attached micropillar apparatus.

2. Eggs of Stegomyia—

   Laid singly about 50. Irregularly oval, thicker at one end and have a corrugated surface (having air bubbles). Ova larger than those of Anopheles.

3. Larvæ of Culex and Anophelines—
   Siphon tube, siphonic index. Siphon tube short in Stegomyia and long in Culex; absent in Anophelines. Palmate hairs on Anophelines.

4. Heads of Male and Female Culex and Anopheles—
   Antennæ, plumose and pilose ; Palpi club-shaped and acuminate.

4*a* Stegomyia, eggs, larvæ and adults.

5. Method of collecting and breeding mosquitoes.

6. Method of feeding mosquitoes.

7. Dissection of viscera—
   Midgut, hindgut, malpighian tubes, ovary, æsophagus, rectum.

8. Salivary glands—
   Dorsal, ventral and middle gland ; salivary duct. Salivary receptacle. Pairs of legs.

9. Sporozoites in salivary glands—

10. Zygotes in stomach—
    One mature zygote projecting.

11. Dissection of head of mosquito.
    Salivary glands, salivary duct, cerebrum, &c.

12. Evolution of the crescent parasite in an Anopheline, (1—6), parasites as found in stomach wall, (7) isolated sporozoites, (8) sporozoites in the salivary glands, (9) section of stomach wall showing parasite *in situ.*

13. Net for measuring the output of mosquitoes from a marsh.

14. Mosquito-proof hut.
15. Mosquito-proof verandah.
16. Mosquito-proof house.
17. Mosquito-proof cistern (office model).
18. Well cover, full wire gauze, and pump.
19. Well cover, concrete, and trap door of gauze.
20. Success sprayer—pesterining a pool.
21. Municipal fountain covered with concrete.

22. The Malarial parasites—

Species of parasite.	*Form of segmentation.*	*No. of segments.*
Quartan.	Daisy.	6–12
Simple Tertian.	Grapelike.	15–20
Malignant Tertian.	Irregular.	10–12

23. Pigment in visceræ—
Brain, spleen, liver.

24. Enlarged spleen.

25. Collection of odd water receptacles.
Diagram Nos. 5, 6, 7, 8, 9 and 10.

Post cards giving a succinct account of Malaria in the following form are widely distributed by the Malaria Department.

PUBLIC HEALTH DEPARTMENT, BOMBAY.

Malarial Fever is conveyed by Anopheles mosquitoes after biting a person suffering from Malarial Fever.

The Mosquito lays eggs on any accumulation of water, however small, inside or outside the house, water in wells, empty flower pots, roadside pools, catchpits, choked gutters, etc.

The eggs look like pieces of soot on the water.

The eggs hatch out into larvæ in 48 hours.

The larvæ look like small pieces of stick lying on the water until disturbed, when they swim away backwards and sink to the bottom.

The larvæ become pupæ in about a week.

The pupæ become mosquitoes about 48 hours afterwards.

The mosquito flies away to suck the blood of man or animal and returns to some water to lay eggs every few days, depositing several hundreds.

If the mosquito sucks the blood of a person suffering from Malaria and bites a healthy person, the disease is conveyed, and, 12 days after, the healthy person may take an attack of fever.

Precautions.—Prevent the mosquito breeding by getting rid of accumulations of water. Prevent the access of mosquitoes to the water, or use pesterine or crude petroleum to sprinkle over the water every 7 days. Take 15 grains of quinine weekly, and give 15 grains of quinine weekly to your servants and children, during the Malaria season.

To recapitulate, the measures adopted in Bombay :—

1. Closing of wells and cisterns breeding larvæ.
2. Treatment of all temporary pools and puddles with pesterine.
3. Giving a trial to fish before resorting to legal measures.
4. Distribution of Quinine.
5. Taking steps to fill in hollows, big tanks, and low grounds with a view to remove all potential sources of mosquito breeding.
6. Educating the public and school children by means of lectures with magic lantern slides and also by the distribution of hand bills.
7. Taking legal action where parties failed to comply with our demand.
8. Taking spleen census of children in schools and houses and also of patients attending the Municipal Dispensaries.
9. Examining specimens of blood of children in different parts of the City and also of patients suffering from fever attending the ten Municipal Dispensaries.
10. Examining the different species of Anopheles and classifying them.

RELAPSING FEVER, FAMINE FEVER OR TICK FEVER.

Definition.—Relapsing Fever, Famine Fever or Tick Fever is a specific fever caused by the presence in the blood of a Spirochaetes (Spirillum) characterised by febrile attacks varying in duration.

The Spirochaetes are supposed to be conveyed by the bite of a species of Tick-Ornithodorus moubata, or by inoculation with infected blood.

The disease occurs chiefly amongst the poor and uncleanly ; bad food, defective sanitation, famine and overcrowding are predisposing causes.

Relapsing Fever, formerly confused with Typhus and Typhoid Fever, is quite distinct from either. It is distinguished from Typhus by the occurrence of the relapse, and from Typhoid Fever by the absence of intestinal lesions. In this disease, as in others in this group, the period of incubation varies much, the range being from less than a day to three or four weeks. It may be wholly latent for about a fortnight. Then there is probably a little malaise and nausea, followed by rigors, headache and pain in the back and limbs. There is also fever, which may run rather high, hurried breathing, cough, a flushed face, and some yellowing of the skin over the rest of the body. The yellow skin is considered characteristic. There is generally no rash, but, not uncommonly, rose-coloured spots appear on the chest, abdomen and limbs. This rash may come out on the third day of the fever, or not till the fifth, and disappears in a day or two. In some epidemics the appearance of a rose rash has been the rule. After the onset it is probably five or six days before the disease will be recognised. The persistent yellow in the skin and the rash, if present, will help the practitioner to a correct diagnosis. The dullness over the spleen is always increased, and usually the dullness over the liver is also increased. There is also often distressing billious vomitting and much thirst. After these symptoms have continued from five to nine days, there is a sudden crisis (which may be marked by Diarrhœa, profuse perspiration, a rigor, &c.), and immediately the patient feels well. The crisis and the accompanying fall in the patient's temperature are almost always at night. The relapse generally occurs on the fourteenth day after the fever originally commenced ; thus the intermission is of varying duration. The relapse is ushered in by rigors and lasts from three to four days, the symptoms being those of the primary fever and as severe. The second crisis is also abrupt, and followed by convalescence. Sometimes there is a second relapse, and even a third and fourth, the symptoms in these being less severe. During the intermission and after the relapse the temperature is sub-normal.

Although one of the names given to this disease is "Famine Fever," epidemics have occurred when work was abundant and there was no scarcity of food. Still it is eminently a disease of the very poor and commonly associated with destitution. As a rule, it is not a very fatal disease.

Prevention.

Prevention is easy for those who are careful of cleanliness of bed and bedding and protect themselves by nets and avoid infected areas.

Disinfection of bedding, clothes and beds, sleeping cots and infected dwellings.

The disease occurs in India, Africa, Europe, America and Australia.

FILARIASIS OR ELEPHANTIASIS.

Definition.—Filariasis is an infection of man, mammals, birds, etc., by various species of the genus Filaria.

Filariæ are long slender worms of almost uniform breadth. They have an incurved or spiral tail.

Of human Filariæ man is the definitive host, and certain species of Culicidæ the *intermediary* host.

Filaria bancrofti or Filaria nocturna.—It is found widely distributed in every tropical and sub-tropical country. The sexes are usually found in association up to 6 or 7 in number, all coiled up together and lying in the lymphatics of the trunk or extremities.

The young filariæ are ejected into the lymph surrounding the parent and are carried to the blood stream through the lymphatics and the thoracic duct ; in the blood stream they exhibit a curious periodicity. At about 8 or 9 p.m. these small embryos (micro-filariæ nocturna) begin to appear in the peripheral blood increasing in numbers up to midnight and gradually decreasing thereafter until 6 or 7 in the morning. During the day they retire to the lungs and the larger blood vessels ; thus they are found in the blood only at night time.

The following mosquitoes have been found to act as hosts :—

Culex—
  C. pipiens.
  C. ciliaris.
  C. fatigans.

Anopheles—
  P. costalis.

  Nysso-myzomyia rossi.
  Myzorhynchus sinensis.

Probably the true carriers of Filariæ belong to the genus Mansonia.

About an hour after the mosquito has gorged the infected blood, the blood becomes viscid. The parasites then bore through the wall of the mosquito's stomach and reach the muscles in 12 to 18 hours. They then work their way through the muscular tissues till they reach the neighbourhood of the mosquito's salivary glands and pass into the neck, when one or more can readily enter the substance of the labium. When this mosquito next feeds on man, the Filariæ gain a fresh human host, and ultimately find their way to the lymphatic trunks where the union of the sexes may occur, and the swarm of embryos is eventually poured into circulation thus completing the endogenous and exogenous cycles.

The pathological results of parental Filaria in lymphatics, &c., are :—

1. Lymphangitis.
2. Varicose glands.
3. Lymphatic varices.
4. Chyluria.
5. Elephantiasis.
6. Chylous Ascites and Chylous Diarrhœa.

Elephantiasis is by far the most frequent manifestation of Filarial invasion and exceedingly common in some of the endemic districts.

The lower extremities are most commonly affected (95 per cent.). The scrotum, arms and mammæ are more rarely attacked.

Prophylaxis of Filarial disease.

1. *Anti Mosquito.*—Unprotected wells, tanks, *campaigns* or stagnant pools should not be permitted in the neighbourhood of dwelling-houses. All the vessels used for storing water should be emptied at least once a week.

2. *Isolation of the infected.*—The subject of Filariasis should be regarded as dangerous to himself and to the com munity and compelled to sleep under a mosquito net.

3. *Use of mosquito net for all in the endemic area.*

KALA-AZAR.

Definition.—Kala-Azar is a chronic infectious disease of warm climates, characterised chiefly by (1) splenic Hypertrophy; (2) irregular pyrexia uninfluenced by quinine; and (3) certain gastro-intestinal symptoms, such as Diarrhœa and Dysentery.

Bodies called Leishman-Donovan bodies have been found in the blood by splenic puncture.

The method of propagation is not known but some believe that Cimex lectularius is the intermediate host. The peculiar characteristics of the disease are that (1) it proceeds often in an epidemic form; (2) the infection of a new area can usually be traced to an imported case; (3) the inmates of the house in which he lodges are usually the first to be attacked; (4) the house appears to retain the infection for many months. The parasite Leishmania-Donovani is present in every case of Kala-Azar.

The incubation period is under 10 days.

Prevention.

Guard against the bites of insects when in an endemic area or near a patient. In the endemic region itself it would be safer to isolate all patients and to burn their fomites. The disease should be considered infectious and all ordinary measures for prevention should be adopted.

ORIENTAL SORE OR LEISHMANIA TROPICALIS.

Definition.—Oriental Sore is a specific granuloma of the skin, endemic in certain limited tropical areas, characterised by a very indolent ulceration which is inoculable, and due to a specific parasite identical with that of Kala-Azar.

The specific parasite Leishmania-Donovani is found in the tissues surrounding the ulcer in every case of the disease.

The disease sticks to an endemic area.

It is more common in the town than in the country.

Lesions occur on the uncovered parts of the body, such as the hands, fore-arms, or the face.

It is contagious and auto-inoculable.

One attack confers immunity.

The incubation period varies from 3 to 12 days.

Prophylaxis.

Injuries to the epidermis should be carefully avoided; also the bites of insects or the ravages of blood-sucking flies. Personal cleanliness and other hygienic measures should be adopted. Disinfectants should be freely used.

YELLOW FEVER.

Definition.—Yellow Fever is an acute, specific, febrile infectious disease, characterised by fever, prostration, icterus and albuminuria.

It is now definitely settled that the disease is conveyed by the bite of the Stegomyia fasciata.

The following is a concise resume of the subject :—

1. The incubation period in the human body is from 2 to 13 days—probably, most often, 3 to 5.
2. The disease is carried from the sick to the healthy by the intermediate agency of S. fasciata.
3. No other mosquitoes have so far been proved to carry the germ.
4. The microbe of Yellow Fever is still unrevealed. It must be extremely minute ; since in the serum of the patient the virus will pass (without dilution) through the Chamberland F. bougie, but not through the B. bougie.
5. The serum of a patient is not infective during the incubation period.
6. The serum of a patient is virulent from the first to the third day of the disease and the Stegomyia must bite the patient during that period, or else will not be capable of transmitting the disease.
7. On the fourth day of the disease the blood no longer contains the virus, even if the fever is high.
8. When a mosquito has bitten a patient during the first three days of his illness, it is not until a further period of at least twelve days has elapsed that this mosquito is capable of infecting a healthy person ; and the more this period is exceeded the more dangerous does the mosquito's bite become.
9. The bite of an infected mosquito does not necessarily produce Yellow Fever, and if Yellow Fever is not produced no immunity will be obtained against an injection of virus.
10. The bite of two infected mosquitoes may give a grave form to the disease.

11. Most mosquitoes lay their eggs on the eight consecutive days after they have obtained their first bite. The female Stegomyia does not die after its first batch of eggs has been laid, but lives on until it has deposited seven successive batches, the average period of its survival in the mature state being from twenty to thirty days. It is, therefore, capable of transmitting the infection to a large number of individuals after the twelve days' incubation period of the virus within the insect's body is over.
12. Ova laid more than twelve days after the ingestion of infective blood by the parent mosquito would appear to be capable of infecting the imago, which springs from such ovum; but such mosquitoes hatched out from infected ova do not acquire the power of conveying infection until after the fourteenth day of their existence in the perfect state.
13. It is found that 1 c. c. of serum taken from a patient during the first three days of his illness will produce Yellow Fever in a healthy person if injected under the skin.
14. The virus deposited on a superficial skin abrasion does not produce the disease.
15. The serum of a convalescent possesses definite prophylactic properties which commence on the eighth day and are still appreciable at the end of twenty-six days.
16. The serum of a convalescent appears to have therapeutic properties.
17. Contact with a patient, his clothes, or excreta cannot produce Yellow Fever.

Prophylaxis.

During epidemic visitations non-immunes should immediately quit the implicated zone. Slums and low-lying districts of the town should be avoided. These places should not even be visited, or if visits have to be made to them they should be as brief as possible and not made during the night.

The susceptible should avoid sleeping in the lower storeys of houses and pay great attention to general health. Sailors must not be allowed on the shore. Ships should not be allowed to clear from infected ports, nor to enter non-infected ports during the warm season without adequate inspection. If on entering port Yellow Fever is found on board, the cases should be isolated in a quarantine hospital where there are no Stegomyia mosquitoes, the ship thoroughly cleared of mosquitoes, and the passengers and crews prevented for at least five, better thirteen, days from communicating with the shore, or until every risk of conveying infection has passed away.

In the event of the disease appearing in a locality which is not habitually a Yellow Fever centre, and of which the population is small, an economical plan of dealing with the threatened danger is to remove the entire population of the neighbourhood with the exception of the insusceptible and those in attendance on the sick and to place the deported population in a thirteen days' quarantine camp. The infected area must be rigidly isolated and its mosquitoes destroyed.

In the case of the appearance of Yellow Fever in a large town, the following methods should be adopted :—

(1) There should be early notification and diagnosis in order to isolate the reservoirs* as soon as possible.

(2) General screening of the reservoirs by the use of an isolation hospital.

(3) Isolation by screening the reservoir.

(4) Systematic destruction of mosquitoes as described in the following pages.

(5) Funds and authority must be obtained at once.

(6) An efficient and adequate sanitary staff must be promptly organised and instructed in their duties.

Anti-Stegomyia Measures.

1. Empty all unused receptacles of water and allow no stagnant water on the premises.

---

* Persons harbouring the parasite in their body.

2. Screen cisterns, after placing a small quantity of kerosine oil (a tea-cupful in each cistern) on the surface of the water.

3. Place a small quantity of kerosine oil or pesterine in cesspools or privy vaults.

4. Sleep under a mosquito-net.

5. Screen doors and windows wherever possible with fine screens.

6. Educate the public by lectures, handbills and placards.

Exterminating the Carriers.

Sealing and Fumigation.—

Preparation for fumigation should be started with screening. The entire house must be fumigated. Incomplete and imperfect fumigation are the principal reasons of not being able more promptly to suppress Yellow Fever. The rooms should be sealed from the inside with strips of newspaper or with any stout and thin paper. Stout paper may be used for covering large openings. Paper cut in rolls 3 inches wide is exceedingly useful for pasting along the cracks. Windows may be sealed from the outside in order not to disturb mosquitoes which may be present. The doorway is left open till the last to introduce the fumigating materials and to light up; when this has been done the door is sealed and the time noted in a book kept for the purpose. The responsible officer should personally examine to see that the sealing is carried out effectively. A small open chink admitting light is sufficient to attract mosquitoes to it; then they make their escape. Halls, water-closets or outhouses must not be forgotten. After the allotted time necessary to thoroughly complete the fumigation is up, the doors are opened and the floors swept. Some of the mosquitoes may only be stupefied, and it is necessary that they be all burnt or otherwise destroyed.

After the patient is convalescent, or after death, the patient's room should be fumigated.

The rooms should be carefully measured and materials proportioned to cubic capacities as under; small closets and wardrobes should be opened (Rubert Boyce):—

(1) *Pyrethrum Powder.*—Three lbs. to 1,000 cubic feet applied for 3 hours; it is better that the 3 lbs. be divided among 3 pots than that all the powder be put in one pot. The pots to be placed in pans containing a little water. Pyrethrum powder is used for rooms close to the sick patient, as the fumes which might escape from sulphur fumigation are irritating.

Pyrethrum powder is also used in cases where brass-work, pianos, telephones, instruments, &c., are present.

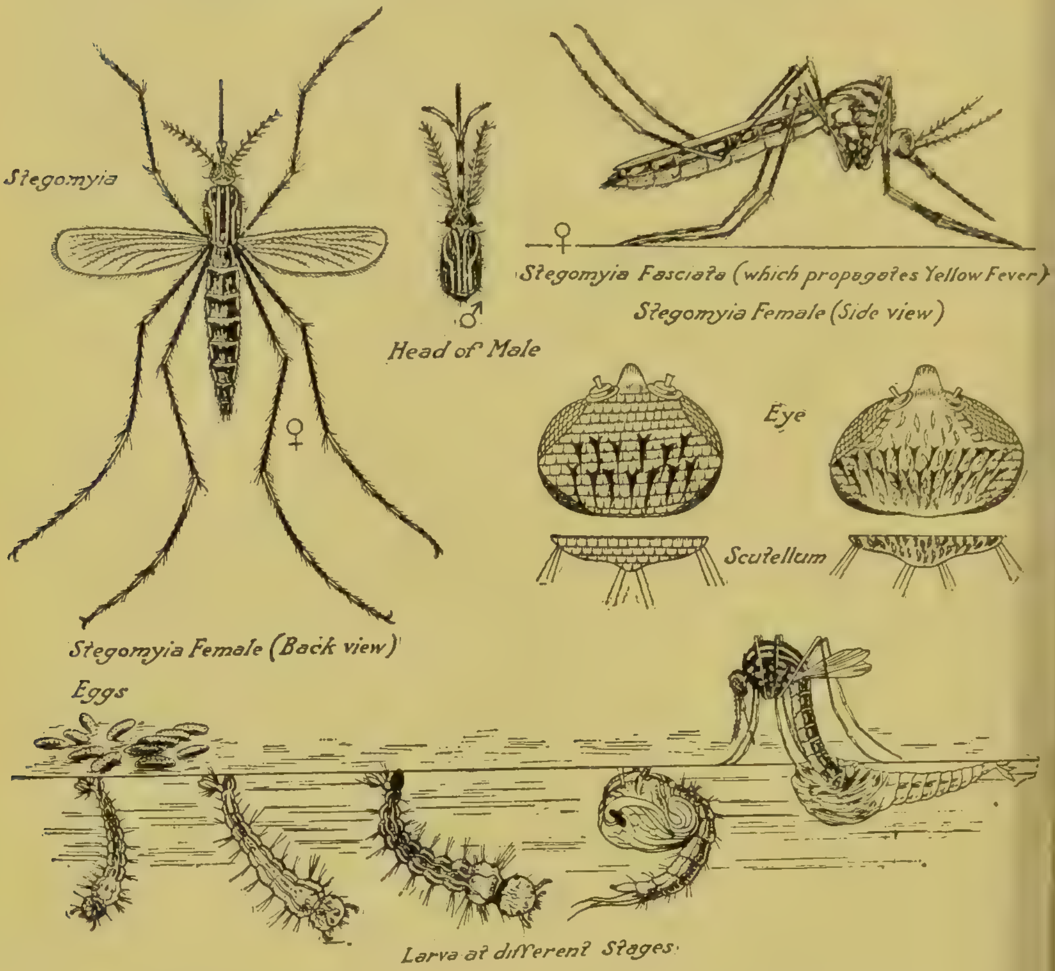
(2) *Sulphur.*—2 lbs. to 1,000 cubic feet. The pots containing the sulphur are to be placed in pans containing 1 in. of water. The sulphur is to be started by alcohol, and care must be taken to see that it is well alight. Duration—three hours. Brass-work and instruments are liable to injury; they should, therefore, be removed.

(3) *Camphor and Carbolic Acid.*—The mixture consists of equal parts of camphor and crystallised carbolic acid dissolved by gentle heat. It is an exceedingly good fumigator, does not injure furniture, clothes or brass-work; the odour is pleasant and smells of camphor. A room has a refreshing smell after its use.

Four ounces are vaporised per 1,000 cubic feet for two hours; the material is placed in an open pan placed over a spirit or petroleum lamp; white vapour is given off.

It is most important that the houses in the vicinity of an infected house should also be fumigated at once.

Stegomyia Calopus or Fasciata.


Stegomyia
Head of Male
♂
♀
Stegomyia Fasciata (which propagates Yellow Fever)
Stegomyia Female (Side view)
Eye
Scutellum
♀
Stegomyia Female (Back view)
Eggs
Larva at different Stages

No. 12.

This shows eggs, larvæ, pupæ and adult Stegomyia fasciata (l'Institute Pasteur de Paris).

STEGOMYIA CALOPUS OR STEGOMYIA FASCIATA.

In the following pages is given a description of Stegomyia calopus or Stegomyia fasciata.

Vide diagram No. 12.

Stegomyia is essentially a domestic mosquito. It seeks the central and more crowded parts of the city. It is indeed a cistern breeding mosquito and is often known on this account as the *cistern mosquito.* It is found in abundance in those places where rain-water is collected and stored.

The mosquito is readily recognised by the white bands upon the legs and abdomen and the lyre-shaped pattern in white on the back of the thorax. It is called the *tiger* *mosquito.* Only the females suck blood and they appear to attack men both during the day and at night.

Each female lays between twenty and seventy-five eggs on the surface of water; these are minute, black and cigar-shaped; they are very resistant, and have been kept in a dry state for periods varying between 10 and 20 days; freezing does not destroy their fertility.

Under suitable conditions of temperature, the eggs hatch out in from 10 hours to 3 days. The result is the well-known "wiggle waggle" or "wiggle tails," the larval stage of the mosquito. The larvæ are very active and very sensitive, and very rapidly disappear from the surface of water in the cistern if the least disturbance occurs.

For this reason, the water barrel or vat must be approached gently if one is desirous of obtaining specimens and examining them,otherwise they wiggle very rapidly to the bottom. Another point has also to be borne in mind, and that is that they cling to the sides of the receptacles and hide in the crevices, so that it is by no means easy to get rid of them. Simply emptying the water out of the receptacle will not suffice; a very thorough rinsing and cleansing is necessary.

The duration of the larval period is from 6½ to 8 days normally; but they may remain in the larval stage for a much longer period. Sir Rubert Boyce brought some specimens alive from New Orleans to Liverpool, a journey occupying twenty-six days.

The pupal stage lasts two days or less.

Larvæ are always found in artificial water containers. The eggs may retain their vitality when kept dry for six and a half months. In searching for Stegomyia larvæ the rain-water barrel is generally found to be the seat of election for breeding purposes. Given an old wooden barrel, just coated with a green slime, and "worms" will almost invariably be found: men accustomed to this work frequently affirm that worms must be in a barrel from its appearance. Yet a cursory examination of the water may fail to reveal their presence. When, however, the water is poured out all but a teacupful at the bottom, and this is well agitated, invariably the worms are found. This property of disappearing to the bottom of the receptacle and hiding in the chinks between the staves, and in the groove at the bottom, is very characteristic. After barrels come washing tubs, olive jars and then every form of water receptacle. They have been found in the blacksmith's shop in his cooling barrel or tank and in logs. Wherever in or around a house water stagnates, there the larvæ will be found. Their presence is a positive test of stagnant water. In the living and bed-rooms they are frequently found in receptacles for holding flowers from which the water is imperfectly removed.

One does not encounter them breeding away from men: they are as domestic as the flea, bug and cat.

In a few instances they have been found in drains in houses mixed with Culex larvæ. It is believed by some that larvæ purify water, that they are useful in drinking water butts, because they will remove pathogenic organisms should any gain access. There is no evidence whatever that they do remove pathogenic germs ; their natural food is green algæ and diatoms.

Stegomyia Survey—

The house, garden and yard should be systematically examined : breeding places, all water, drinking and washing inside or outside the house, and whether contained in cisterns, barrels, buckets, tubs, tins, goblets, vases, wells, anti-formicas, broken bottles, &c.

Mosquito Stage.—A black and white mosquito. Proboscis unbanded ; thorax ornamented with a curved silvery line on each side and two median parallel lines, giving the characteristic lyre pattern. Hind tarsi basally banded with white, the last tarsus being all white.

Egg-laying occurs chiefly at night, sixty to seventy being laid.

The eggs will hatch after being kept dry for some months.

Larvæ.—This stage lasts about a week.

Nymphæ.—This stage lasts 36 hours.

Imago.—In the absence of water in the tropics, it lives only 3 to 4 days.

How to distinguish the Stegomyia larvæ :—

They are longer than the larvæ of Culex fatigans.

Attitude.—Almost vertical.

Head.—Small.

Thorax.—Less conspicuous.

Antennæ.—Small and spineless and have a single hair about the middle, whereas Culex fatigans has large branched hairs.

Syphon tube.—Dark, short, stout and the syphonic index is 2. Worm-like wriggling is the mode of progression.

Pecton spines.—Two rows on the posterior aspect of the syphon tube.

Combs (*scales*) on the eighth segment at the base of the syphon.

CHAPTER VIII.

DISINFECTION.

Disinfectants are the agents which destroy the germs of disease or the infective material which convey those germs. An *antiseptic*, on the other hand, is a substance which merely restrains the growth of organisms and prevents animal and vegetable matters from decomposing. *Deodorants*, which are frequently confused with disinfectants, are substances which serve to cloak offensive smells either by their own odour or by oxidation.

Complete disinfection is that in which both bacteria and their spores are destroyed and *incomplete* is that in which the bacteria only are killed. In practice disinfection is accomplished by the agency of heat and chemical substances, but there are certain accessories which play an important part and may properly be considered here, *viz.*, mechanical cleansing, light and desiccation.

Mechanical cleansing.—Cleansing with soap and water unquestionably removes many organisms and the scrubbing of floors, furniture and woodwork is a necessary adjunct to chemical disinfection. Again, in disinfecting a room lately occupied by a phthisical patient, the removal of dust from the walls by means of dough as advocated by Esmarch affords a valuable safeguard to the workman employed, as the dust is entangled in the dough instead of being scattered about. The dough is subsequently destroyed by fire.

Light is a most important factor in keeping down the number of bacteria, as it has a deleterious action on them in their vegetative form and to a less extent in their spore form. The ultra violet rays are much more powerful than the infra red. The effect is increased by the presence of air and moisture and is probably due to a process of oxidation, varying according to the duration of exposure, the intensity of the light and the variety of organism present.

Desiccation or drying may kill many of the non-sporing organisms, *e.g.*, staphylo and strepto-cocci, Typhoid bacilli, etc., but the spores of spore-bearing organisms are not destroyed. They resist drying for an indefinite period and really become more difficult to kill by other means. The Anthrax and Subtilis bacilli are examples of this latter class.

Valuable though these accessories are, public authorities have to take more active measures, and these include the use of heat in one form or another or of chemical substances.

Objects of Disinfection.—It may be necessary to employ agents for the destruction of known germs of disease, or for the destruction of the infective material of other diseases, the causative agent of which has not yet been isolated but which is in all probability organismal in nature. On the other hand, the main object may be not so much the destruction of the germ itself directly as the destruction of the carrier of the germ. Modern research has clearly demonstrated the part played by certain insects in the spread of communicable diseases and it may be against such carriers more particularly that our efforts should be directed, *e.g.*, fleas in Plague, certain varieties of Anopheles mosquitoes in Malaria, Stegomyia mosquitoes in Yellow Fever, flies in the spread of Cholera, Typhoid and intestinal diseases such as Diarrhœa, etc. Again, the destruction of organisms may be necessary for the preservation of food materials, *e.g.*, sterilization of food in the process of tinning such materials. It cannot be too clearly understood by the Inspector that disinfection is not meant to replace cleanliness and that the wholesale sprinkling of foul surfaces and objects with disinfectant fluids and powders is a procedure both wasteful and useless. Preventive medicine demonstrates more and more the value of cleanliness and that to cloak the smell of foul and decomposing matter with a powerful deodorant is a waste of time and indicative of an entire absence of knowledge of the true use of such agents, or of gross negligence. This matter is referred to here because one so often sees such practices adopted, and for this sanitary authorities are themselves much to blame,owing to the indiscriminate distribution of so-called disinfectants to householders, without first explaining the imperative necessity of removing the source of nuisance before applying deodorants or disinfectants.

Disinfection by heat.—Heat as a disinfectant may be employed in the form of dry heat or moist.

Dry heat.—As dry, hot air depends upon conduction and only very slightly upon convection for its action, it cannot penetrate very far into bulky articles. Disinfection by dry heat has been almost universally superseded by disinfection by moist heat on account of the disadvantages associated with the former, which may be summarised as follows. The duration of exposure and degree of temperature attainable are limited by the tendency to scorch. Its penetrative power is small and articles, which on the surface are scorched, may in the interior never have been heated to a proper temperature. It is slow in action and its germicidal power is less than that of steam at any given temperature. Moreover some parts of the hot air chamber are hotter than others and consequently infected articles are acted upon unequally.

DISINFECTION BY STEAM.

Steam is the agent used by most public authorities at the present time for the disinfection of bedding, clothing, etc. It enables a higher temperature to be reached without danger to the articles, and moreover it has a much greater penetrating power than dry heat, and is more rapid. The steam may be supplied to the disinfector either from an existing boiler used for some other purpose, or from a special separate boiler used only for the disinfector, or lastly, the jacket of the disinfector may serve as a boiler, examples of which will be referred to at a later stage.

Steam at a given pressure is not equally efficient, whether it is used as saturated steam or super-heated steam. Saturated steam is steam at a temperature very slightly above that at which it has been generated and therefore condensing on being slightly cooled. Super-heated steam is steam at a temperature at least several degrees above that at which it was generated and so resembling gases in that it requires to be compressed, or cooled considerably, before passing into the liquid state. It is a bad conductor of heat, resembling air in that respect. Saturated steam, on the other hand, can easily convey heat and, on coming in contact with cold objects, condenses and in doing so imparts its latent heat to those objects and shrinks very considerably in volume ($\frac{1}{1600}$). When the temperature of the object is raised sufficiently, the water thus condensed is vaporized again. When this takes place in connection with a pillow or other porous article, successive layers become heated in turn, provided always that the contained air is allowed to escape ; otherwise, if allowed to remain, it interferes with the penetrative power of the steam and therefore with rapid heating.

Super-heated steam is saturated steam, which, after having been removed from the presence of water, has been surcharged with heat. It cannot endure in the presence of water, as the latter will absorb the surplus or super-heat until the steam reverts to the saturated condition.

Defined in another way, saturated steam is fully evaporated water. It is perfectly dry and contains in a given volume, and at a given temperature, the maximum weight of evaporated water and incorporated heat. In the boiler it has the same temperature and pressure as the water from which it is produced.

Steam either in the saturated or the superheated condition may be confined, or it may be in motion, *i.e.*, current steam. Moreover it may be used at atmospheric or low pressure or at high pressure. The term 'low pressure' as applied to disinfectors means steam given off at boiling-point and atmospheric pressure. Similarly, 'high pressure' means only a pressure of 10 to 15 pounds, representing at ten pounds a temperature of 115° Centigrade. Very many experiments have been made by different observers to test the relative efficiency of various types of disinfectors. Esmarch using Anthrax spores and current superheated steam concluded that current steam should never be superheated. Such steam cannot condense until it has been cooled to the saturation-point and consequently it can only act as dry, hot air by conduction. The use of superheated steam means a longer exposure and consequently a greater consumption of fuel and more liability to injure the articles, with less reliability as to disinfection.

Air in the interstices of the clothing greatly interferes with the penetration of the steam. This difficulty can be overcome in various ways. One method is to pass a rapid current of steam through the chamber, which must be provided with a sufficiently large outlet and means whereby steam can be generated rapidly. Another method is to provide a vacuum or exhaust pump to extract the air prior to disinfection, and a third way is to, from time to time, intermit the pressure within the chamber. The sudden reduction of pressure causes an expansion of the steam in the interstices of the material under treatment, and vaporization of the moisture contained therein which displaces the air in the articles.

Much has been written by the supporters of the two different systems, *viz.*, current steam and saturated steam under pressure. The former is cheap, the apparatus is simpler and is easy to work. For many, if not all, practical purposes the prolonged exposure of infected articles to a rapid current of steam, especially if that steam is kept a few degrees above condensation-point, produces disinfection and, if prior to the introduction of the current steam, a vacuum or partial vacuum is produced, the penetrative power of the steam is increased and its action is more rapid and powerful. Current steam is eminently suited for small installations and where skilled labour is not available. The opponents of this system object to it on the ground that it is difficult to control the rate of the current and the rate at which the steam is generated, and they claim that with saturated steam under pressure there is a constant and efficient condition under control, and that in practice it is easier to expel air by this method than by current steam. Steam under pressure, however, requires a much heavier and more costly apparatus.

Whatever type is used, for practical purposes it is necessary that the chamber be of a suitable size, the most useful being one which is about 6 to 7 feet in length and 4 to 5 feet in depth.

The rapidity of the penetration of heat into articles is ascertained by placing within them a thermometer, which on registering the required temperature rings a bell by reason of the mercury completing the circuit of an electric current from a battery. The efficiency of the provision for drying the articles is gauged by the amount of moisture remaining in them after removal from the stove, as calculated by the increase in weight of the article. The maximum temperature reached in the stove and the uniform distribution of the heat may be tested by means of recently standardised maximum thermometers wrapped up in blankets and exposed in the stove; and the pressure within the stove can be ascertained at any time by the pressure-gauge.

Of the numerous types in use in the different parts of the world, a few of the better known ones may be referred to.

Goddard, Massey and Warner's.—A high pressure apparatus. Is more or less square in shape. It is steam-jacketed and has steam-jacketed doors. The jacket of the apparatus is half filled with water and serves as a boiler, the furnace being situated immediately below it. The pressure in the jacket is usually limited to 20 pounds and the pressure in the chamber is the same or slightly lower. Arrangements are made to pass a current of hot air through the chamber, immediately before and after disinfection, by means of which the articles are warmed prior to, and dried subsequent to, disinfection. Exposure for twenty minutes is usually allowed.

This apparatus can be supplied with a separate detached boiler if desired.

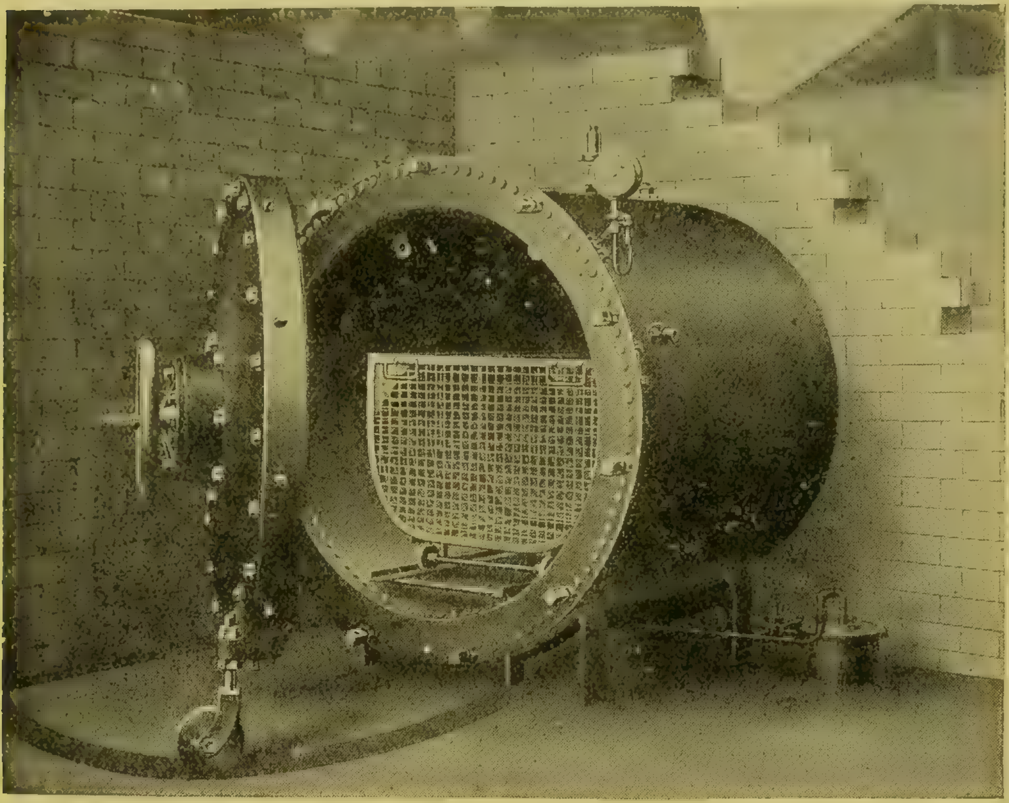
The Equifex Disinfector uses saturated steam under pressure; originally made by Geneste Herscher and Co. of Paris. This apparatus has no jacket but has the usual two doors which are provided with wheels and floor rails to facilitate opening and closing, and also rails on which runs a wheeled cradle for the clothing. The steam is derived from a boiler which is quite distinct from the apparatus itself. Several sizes and types are constructed. One type, which is used both by the Bombay Municipality and the Bombay Port

Health Authorities, works with a pressure of from 7 to 10 pounds per square inch. Another type works at from 2 to 5 lbs. pressure. Means for producing a vacuum in the chamber are provided and there is a coil of pipes containing steam running through the chamber ; these coils assist drying after disinfection and also prevent undue condensation of steam. At intervals the pressure of steam is intermitted. In recent patterns there is a recording gauge, which traces on a chart the temperature in the chamber throughout the whole period of disinfection, thus serving as a check on the attendant in charge. The exposure allowed is usually about 20 minutes. The cylinder is covered outside with a non-conducting composition and wood to reduce loss of heat by radiation and furnished with separate doors for infected and disinfected articles respectively.

The Washington Lyon is oval in section. It opens at both ends, and has a jacket surrounding the wall of the disinfecting chamber, between which there is a space of 3 to 4 inches. A vacuum-producing apparatus is provided. It has a separate boiler, and the pressure at which it works is about between 10 to 20 lbs. per square inch. As at present used, the pressure in the jacket is somewhat lower than that in the chamber, the main use of the former being to heat the latter before steam is turned into it. The doors are non-jacketed. Before commencing disinfection proper, a current of steam should be allowed to pass through the chamber. 10 or 20 minutes suffice for the penetration of even bulky articles ; when disinfection is complete the steam is allowed to escape from the chamber ; the door is opened and the articles removed.

If it is desired to dry the articles thoroughly, they may be exposed to the heat of the steam in the jacket.

Messrs. Manlove, Alliot and Co.'s High Pressure Disinfector.—The chamber is provided with a jacket, and, as the pressure of steam in the latter is somewhat greater than in the chamber, the steam in this is slightly superheated. A vacuum apparatus is provided, which serves both to remove air and, after completion of disinfection, to draw a current of dry, hot air through the apparatus, thus drying the articles contained therein.



NEW TYPE THRESH CURRENT STEAM.

Thresh's Low Pressure Disinfector consists of a chamber surrounded by a jacket, which contains a solution of calcium chloride. The jacket acts as a boiler, the furnace being situated underneath. The salt present raises the temperature at which the water boils and the steam rises at about a temperature of 106° C. without applying extra pressure. It is a low pressure current steam apparatus, the steam being slightly superheated. The process is finished in about an hour. The apparatus is simple, cheap and efficient.

As the water of the boiling solution evaporates, an equivalent amount is automatically introduced from a small cistern with a ball valve arrangement.

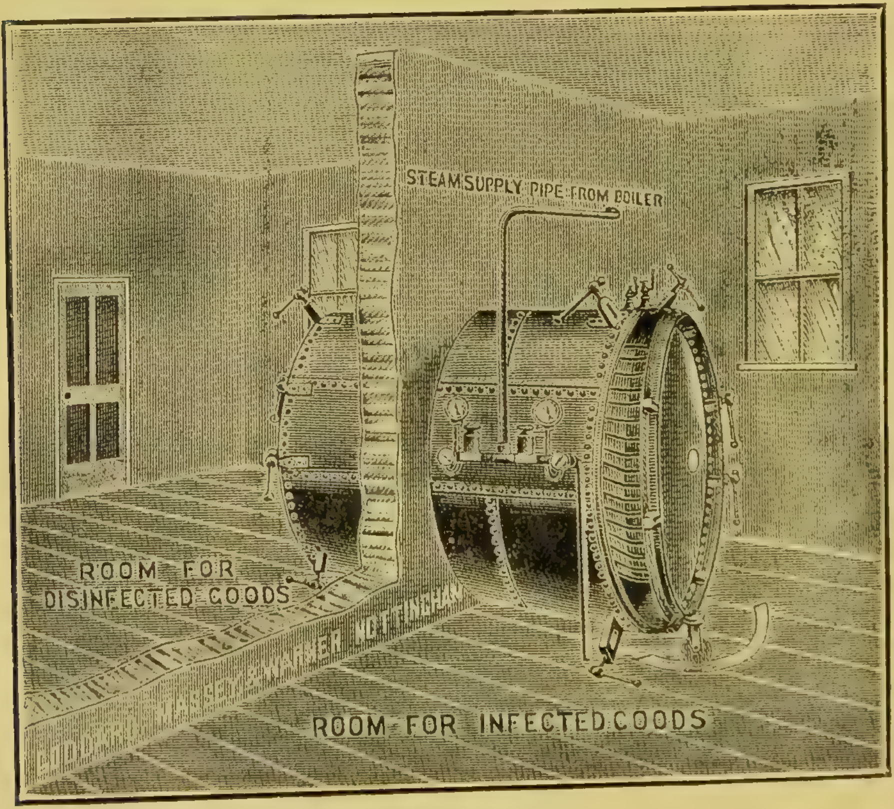
The Reck Apparatus is largely used in Denmark. It is on the low pressure current steam principle. It has no jacket. There is an arrangement by which a cold water shower can be turned into the chamber, with the object of removing all steam from the interior in the shortest possible time after disinfection.

The water is not permitted to fall on the clothes. The low pressure steam is delivered to the apparatus by an automatic regulator at a rate which cannot be exceeded. For ordinary work the pressure is about 1½ pounds. The sudden introduction of the cold shower causes a rapid cooling and condensation of all live steam in the chamber, the vacuum produced being replaced by air entering through a valve in front of the apparatus.

The steam enters at the top and the exhaust outlet is at the bottom. The current of steam passes through, the whole time. The steam is at a temperature of about 104° C. to 106° C.

The apparatus is cylindrical in shape, three feet in diameter and seven feet long.

The arrangement for drying consists in a simple water jacket that surrounds most parts of the disinfector. During the steaming process, the water in the jacket is heated to the same temperature as the interior. When the process of disinfection is completed, air is allowed to pass through the disinfector, and the water jacket gives off heat enough for drying the articles completely before they are taken out.



A DISINFECTING STATION should comprise—

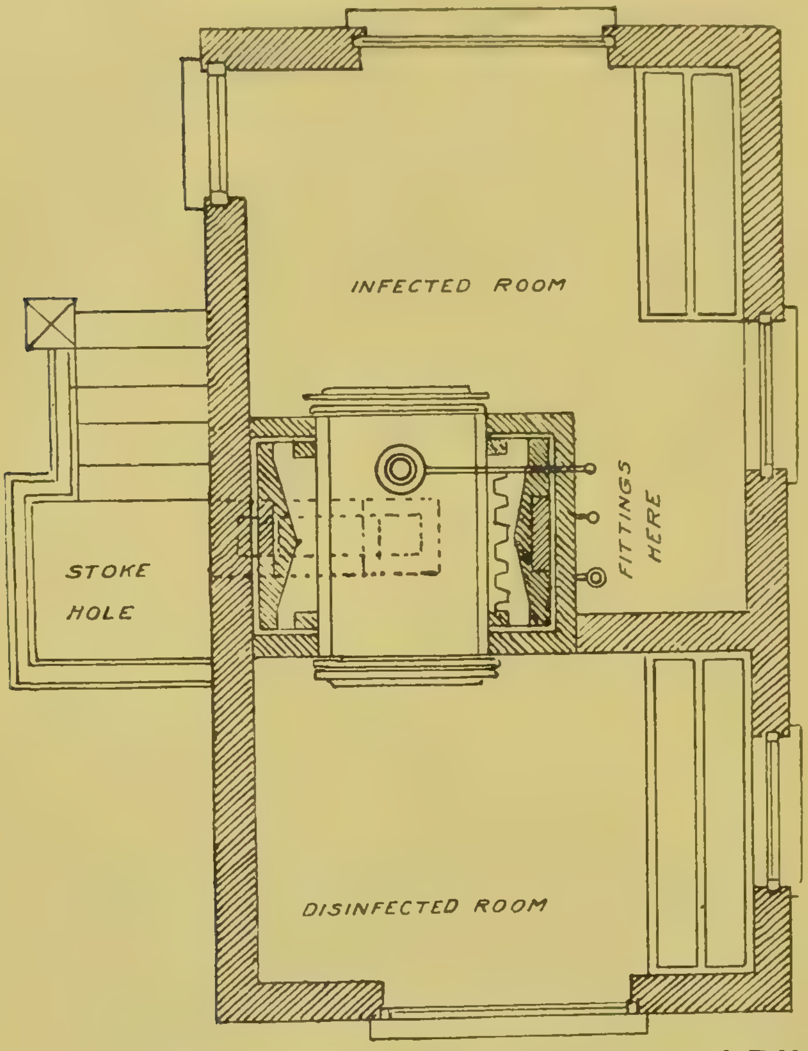
(1) Two rooms completely separated from each other by a wall into which the stove is built, so that it communicates with both rooms. The infected articles are brought into one room and placed in the stove, and after disinfection they are removed from the other end of the stove, which opens into the non-infected room. No infectious material must be allowed to enter the non-infected room, and there should be no direct means of communication between it and the infected room. The floors and walls of both rooms should be made of some smooth and non-porous material, which can be readily and efficiently cleansed by water; and exceptionally good provision should be made for ventilation and light. If good ventilation is not provided, the rooms become very hot in the summer time, and it is a good plan, in order to reduce the heat and to protect the articles from dust and smoke, to arrange that the stoke-hole and coal-store are outside the compartments when the furnace is immediately under the disinfecting oven; and even when the boiler is separate, the stoke-hole and coal-store should be placed in a small compartment, shut off from the working rooms.

(2) An incinerator and destructor, provided with a small second fire to cremate the products of imperfect combustion before they pass up the flue.

(3) Separate sheds for (*a*) vans employed to bring in infected articles, and (*b*) those employed to return the disinfected articles.

(4) A laundry and bath-room should also form part of a disinfecting station, and a charge may be made for

any laundry work undertaken after the disinfection of infected articles.



—PLAN OF SUITABLE BUILDING—

FOR DISINFECTION STATION.

The Disinfecting Station proper.—The walls should be lined with glazed brick or tiles, carefully jointed, or with some other hard, smooth and non-porous material; and there should be as few angles as possible to harbour dirt. The floors should be laid in concrete, grouted over to a smooth surface with cement, and with ample provision for drainage. The rooms for infected and disinfected articles, respectively, should be so arranged that direct communication is impossible and the doors of these rooms should be placed at the extreme ends of the building.

Collection and delivery of articles.—Separate vans should be used for the infected and clean articles, and these should have distinctive colourings; as by picking out with red the infected van, and the van delivering the clean load with white. They should be zinc-lined, and constructed internally so as easily to be cleaned. Such vans cost from £50 to £60 each. The vanmen should have books with duplicate lists of the articles removed, which lists should be initialled by the owner on collection and after delivery.

The system of collecting the smaller articles in canvas bags, which can be put direct into the oven, is generally adopted. By this arrangement, the risk of articles belonging to different premises being mixed at the station is almost removed, but separate parcels must always be made of articles which are damaged by steam disinfection. It is a good plan to place coloured fabrics in bags separate from the white articles; and if each article is carefully folded up and packed in the bag, the articles are not so badly creased as is otherwise often the case.

DISINFECTION BY CHEMICAL SUBSTANCES.

Chemical substances are most usually employed in either a gaseous or a liquid state. They may act on organisms in three different ways:—(1) by attenuation, the organism losing its pathogenic action, *e.g.*, Anthrax bacilli immersed in a solution of carbolic acid of a strength of 1 in 1,000; (2) by inhibition, *i.e.*, the organism is unable to grow or multiply in the presence of the chemical, the removal of which, however, enables growth to proceed; and (3) by killing the organism outright, *i.e.*, exercising a true germicidal action.

An ideal disinfectant should possess the following properties. It should be cheap, of constant composition, readily soluble in water, easy of manipulation and certain in action, and it should be able to act even in the presence of organic matter, *e.g.*, urine and fæces. It should be non-poisonous, non-corrosive, non-bleaching, and non-injurious to wood, linen, paper and metal.

Disinfection, in general, presents many difficulties in this country. In a very large number of cases gaseous disinfectants are precluded from use, owing to the structural arrangements of the house. The difficulties of making the poorer class residences even comparatively air-tight are almost insuperable. The walls and roofs are not even water-tight and in many instances rat-runs communicating with the exterior are of common occurrence. Then, again, the value of many liquid disinfectants is negatived, owing to the prevalent custom of having earthen floors which are periodically smeared with cowdung. The presence of so much organic matter largely interferes with the action of disinfectants. In the better class houses, however, these conditions do not obtain and for that reason it is proposed to describe certain disinfectants, largely used in the Western hemisphere, as there is no reason why they should not be used with the same amount of success in this class of dwelling.

The consideration of the particular disinfectant to be used on any given occasion largely depends on the nature of the disease and its mode of spread. This is necessitated because some disinfectants, which may have a rapidly fatal effect on bacteria, may entirely fail to kill fleas or bugs, etc., and obviously therefore, if a disease is spread by the latter agency, some disinfectant which combines a pulicidal and a bactericidal action is indicated. For example, Capt. Gloster, I.M.S., has shown that an acid solution of corrosive sublimate, even in the strength of 1 in 500 failed to kill fleas after an exposure of ten minutes. Perchloride of mercury is an excellent disinfectant after many diseases, but it is obviously not indicated in a disease such as Plague which is spread largely by fleas. Then, again, Clayton gas, which has such an excellent effect in ships, has been shown to be more or less ineffectual in the typical Indian poorer class dwellings, by reason of the impossibility of making them anything approaching air-tight. It is imperative, therefore, that the responsible authority should select a disinfectant with due regard to local conditions : in some case a gaseous one can be used, in others it is contra-indicated ; further, in certain instances the ordinary well-known liquid disinfectants can be used, whereas in other cases a pulicidal and bactericidal agent is necessary, *e.g.*, in Plague, Remittent Fever, etc. With this reservation we may pass on to the more common gaseous disinfectants and their method of use; these include sulphur dioxide, formaldehyde, chlorine and, of more recent date, producer gas.

Sulphur Dioxide.

This gas can be generated by burning sulphur either in the form of a powder or in rolls, cones or candles. Of recent years, cylinders containing the gas in a compressed form are on the market, thus reducing the risk from fire. Another method of generating the gas is by burning carbon bisulphide in a lamp. Comparatively recently, an invention known as the Clayton Gas Apparatus has been introduced, which forces the gas into the room to be disinfected and thereby brings about a greater concentration and diffusion of the disinfectant than in the older methods.

Before using any gaseous disinfectant it is necessary to close all openings and crevices. All windows, doors and fireplaces, if present, must be closed with gummed paper, and when all possible sources of ventilation have been sealed except the exit from the room, the walls and floor should be moistened with water, as the gas has a more powerful action when moist, and finally having started the operation the exit should be sealed. When rolls or powdered sulphur is used, the quantity allowed should be one pound for every 400 cubic feet of air space. It should be placed in a fire-proof receptacle over water and to aid its ignition alcohol in small quantities may be poured over it. If cones or candles are used, the number required will depend on the amount of sulphur in each. At the end of about 8 to 10 hours, the room may be entered and the doors and windows opened wide.

Sulphur dioxide acts as a powerful reducing agent, uniting with the oxygen of many substances to form sulphuric acid; on the other hand, it may occasionally give up oxygen. As a disinfector and destroyer of rats, Klein and others have shown that this gas can be quite as powerful germicidally as formalin.

Of recent years the Clayton Disinfecting Company have placed a series of machines on the market. These machines can be classed under two heads, *viz.*, (1) High Strength Gas

Machines and (2) Dilute Gas Machines. Disinfection by the former is carried out by converting a part of the atmosphere in a room into a gas containing from 12% to 18% of SO. and allowing this to mix with the rest of the air in the room. This strength is suitable for hospital wards, rooms and empty holds of ships, but for holds filled with cargo or for warehouses closely packed with merchandise, the Dilute Gas Machine is preferable. This will rapidly convert all the air in a room into a gas containing 3% SO_2. In this system, the air in the compartment undergoing disinfection is extracted, and, as it is drawn through the machine, becomes converted into a disinfecting gas at a high temperature by passing over burning sulphur in a specially constructed generator. It is then cooled and forced by pressure back into the compartment. Delivery and suction operations, which are produced by a powerful blower, proceed simultaneously and the volume of air withdrawn is equal to the volume of disinfecting gas delivered into the chamber, so, if any leakage occurs it is only due to diffusion. The room must be properly closed by pasting up doors, windows, fireplace, etc.

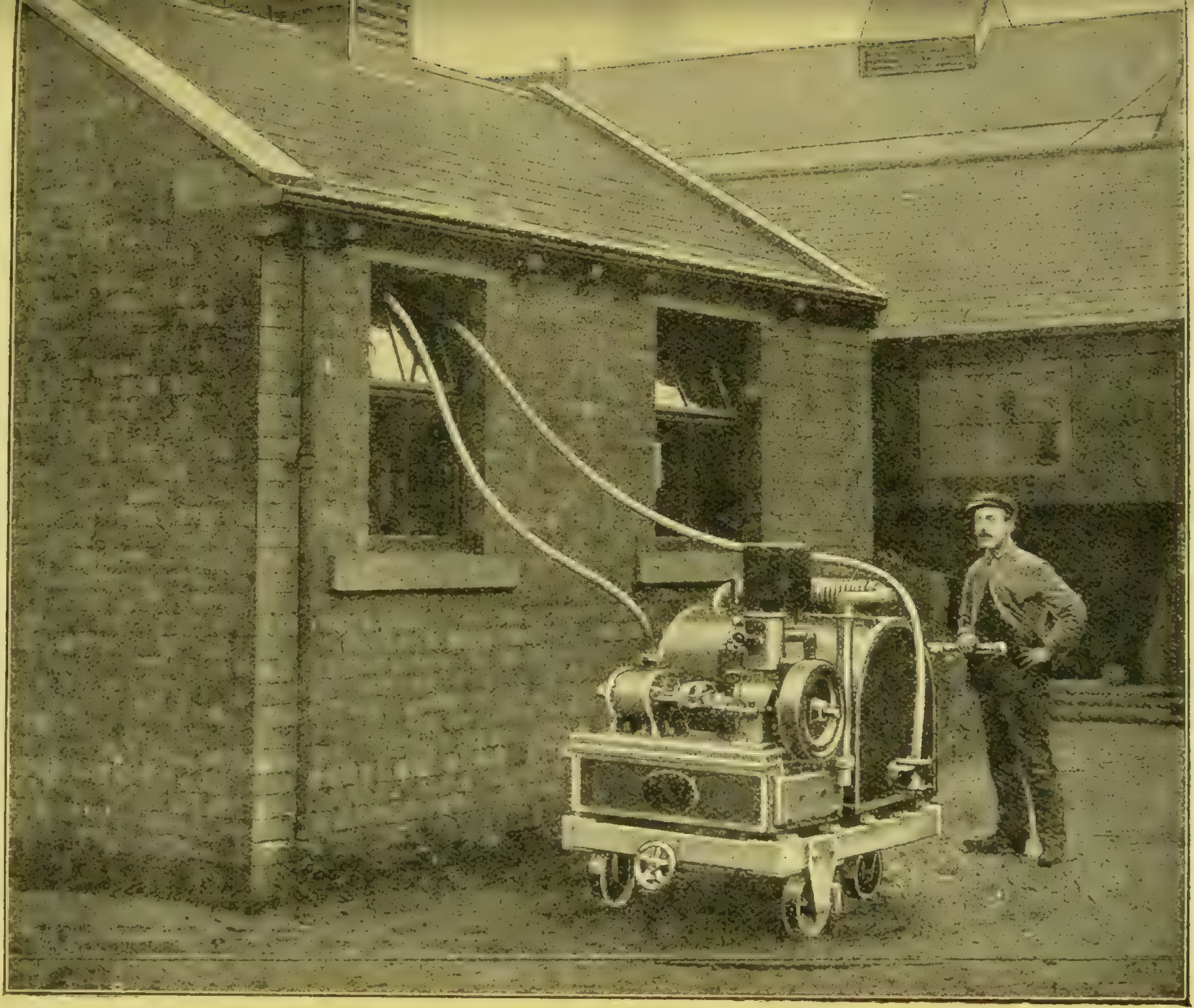
The advantages claimed for the machine are :—

(1) The heat from the combustion of the sulphur is not set free in the room and, consequently, damage due to condensation of water vapour is eliminated, *e.g.*, discoloration.

(2) The room can be charged with gas for as long as desired at a given strength.

(3) Certain types of machines (*e.g.*, A & B) can be employed for extinguishing fires in closed compartments, *e.g.*, ship-holds. Experiments were carried out for the Local Government Board in 1905-6 by Mr. J. Wade to determine the efficiency of Clayton gas in disinfecting cargo in the holds of ships.

For this purpose a model ship's hold, stowed with a general cargo, was used ; means were taken to enable samples of gas to be drawn from any part for analysis, whilst rats and bacterial cultures were inserted to thoroughly demonstrate the action of the gas. Cultures, dried on paper and enclosed



Clayton Disinfector.

in glass tubes, as well as cultures planted in agar, were used, and over 1,100 tests of gas were made.

A summary of the results is given below :—

"Rats and insects would be destroyed in less than two hours by the uniform diffusion of at most 0·5 per cent. of sulphur dioxide. This condition is easily and quickly realised in cabins and empty holds, and in the space around the cargo in a loaded hold ; but, owing to the extensive absorption of this gas, air containing 3 per cent. of it must be circulated around the cargo for 8 to 12 hours to ensure adequate penetration.

"Pathogenic bacteria in exposed places would also be destroyed by the above treatment, and if the hold be closed for a like period afterwards, sufficient penetration will have taken place to ensure the disinfection of all those parts of the interior of the cargo in which these bacteria are likely to be present. Complete penetration can in extreme cases be secured by repeating the fumigation without opening the hatches,

"Textile fibres and fabrics, metals and furniture are not affected by sulphur dioxide, but are liable to injury by the accompanying sulphuric acid, when the gas is produced by burning sulphur, unless they are protected by means of a suitable covering. Jute in bales is not affected in any case.

"Moist food stuffs, such as fruit, vegetables and fresh meat, are uneatable after exposure to sulphur dioxide, and wheat in bags is rendered useless for bread-making ; but owing to the slowness of penetration, wheat in bulk is not seriously affected. Barley and maize are practically unaffected by fumigation with sulphur dioxide."

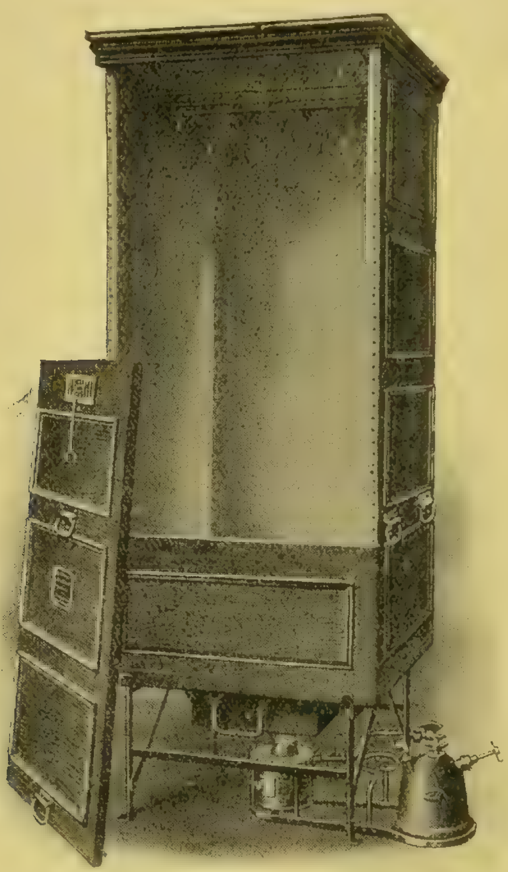
The gas evolved appears to consist mainly of the residual nitrogen of the air and a small amount of unconsumed oxygen with sulphurous acid in varying amounts up to 15 % and a considerable amount of sulphuric acid in suspension, the presence of which makes the mixture white and opaque.

In various experiments in ships, it has been found that when the hold was empty, Plague and Cholera germs were destroyed after a few hours' exposure to an atmosphere containing about 5 % of SO_2. Rats were readily killed in two hours, so also fleas and cockroaches with a uniform diffusion of not more than 0·5 % of SO_2 through the hold of the ship. The duration of exposure proved to be of more importance than the degree of concentration of the gas. With a cargo in the hold, the results were somewhat different. The penetrating power of the gas was found to be very gradual, more particularly in the case of woollen and other fabrics (not cotton) done up in tight bales. This is due to the property which the fabrics have of absorbing the gas ; this absorption takes place in the outer layers of the bales. Wool was found to absorb as much as ten times, and jute at least four times its own volume of the gas. Similar absorptive action was shown by grain and other food stuffs and in the case of flour, the amount of sulphurous acid retained made the flour useless for baking. With a hold full of cargo it is probable that all germs and all rats and fleas cannot be destroyed. It has been found that, if it is desirable or necessary to disinfect a ship before discharge of cargo, a small proportion of producer gas (say 10 %) should be added to the Clayton gas. The machine drives the sulphur fumes into the lower part of the hold and extracts air from the upper.

In a modern city, composed of well-constructed houses, one can readily understand that these machines can and do perform their work satisfactorily, due to the fact that the rooms can be rendered approximately air-tight, but in the ordinary lower class Indian dwellings such a necessary condition is impossible of attainment, and in Indian villages the great majority of the houses have walls made of bamboo laths and mud or of kerosine oil tins. Moreover, rat-runs or burrows abound and to make such a dwelling rat-proof prior to disinfection is obviously hopeless.

Experiments recently carried out at the Bombay Bacteriological Laboratory would appear to show that rats can readily be killed with Clayton gas, when they are confined in an open room, but, if they are allowed to move about freely, some may escape before the concentration of the gas becomes strong enough to overcome them ; moreover, certain types of burrows may afford shelter to the rats and thus they escape destruction.

In the Presidency towns and many cities of India, where numerous well-constructed modern houses exist, this method of disinfection can readily be carried out.



THE EMERGENCY DISINFECTOR.

Formaldehyde.

The germicidal action of this gas has been clearly demonstrated and many devices have been suggested for its use.

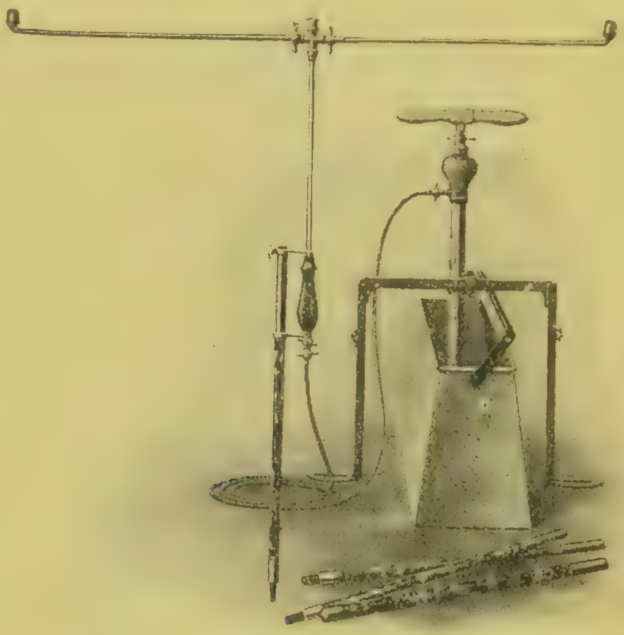
Trillat's Autoclave.—The apparatus is worked from outside the room which it is desired to disinfect, the gas being introduced by means of a tube or nozzle. The autoclave is charged with a mixture of formalin, glycerine, calcium chloride and water. Heat is then applied and the pressure raised to 50 or 60 lbs. ; the cock is then opened and the ejection of gas begins and continues until the pressure falls to 20 lbs., when the pressure is again raised and the process repeated so long as vapour continues to rise or escape from the nozzle of the autoclave.

Lingner's Apparatus comprises a central receiver which is charged with formalin; surrounding this is a ring boiler containing water, and this is heated by means of methylated spirits contained in a heating ring underneath the boiler. When the water in the ring begins to boil, the steam passes through a pipe into a central receiver, and the combined steam and formalin are conveyed by means of four nozzles into the atmosphere of the room in the form of a fine spray. The bacteriological tests with this apparatus have proved satisfactory in the highest degree.

Schering's Method.—Tablets of paraformaldehyde are volatilised by burning over methylated spirits in a patent lamp. The tablets weigh one gramme each. In Germany the Aesculap lamp is largely used for the purpose; in England the Alformant lamp, and more recently the Hydroformant lamp has been devised to yield more moisture than the other patterns. By this latter lamp water is converted into steam at the same time as the tablets into gas. For every 100 cubic feet of air space, five tablets should be burned.

Formegene Richard.—In this apparatus there is a central reservoir containing methyl alcohol, which is conveyed to specially constructed burners by V shaped tubes. In connection with each burner there is a wire-case containing platinised asbestos, and also a wick and chimney. So long as air reaches the wick from below, the alcohol will continue to burn, but by tightening up a special screw one can extinguish the flame. When the platinised asbestos has been sufficiently heated the flame is extinguished, and the vapour of the methyl alcohol, continuing to rise, passes over the heated asbestos and, being only imperfectly oxidised, splits up into water and formic aldehyde. One lamp containing about three litres of alcohol is sufficient for a room containing about 3,000 cubic feet.

The Potassium Permanganate—Formalin Process.—In this method a solution of formalin is poured on to crystals of permanganate, resulting in the very rapid evolution of gas which has been shown by Professor R. H. Firth to consist of formaldehyde, water vapour, carbon dioxide and traces of formic acid. For a space of 2,000 cubic feet about ten ounces of permanganate and one pint of formalin are required The walls of the rooms should be first damped and the air sprayed with water.



MACKENZIE SPRAY.

The Sheet Spraying Method.—Two sheets hung at an angle of 45° are damped and then sprayed uniformly with a given quantity of formalin.

Formalin solution can also be applied by means of a sprayer, of which there are several patterns on the market.

The Trenner Lee Method.—Formalin is heated to boiling-point in a retort, as a result of which formaldehyde gas and water vapour pass out into the room.

M. Daniel Base conducted experiments to determine the amount of formaldehyde gas given off by a definite quantity of formalin by five well-known methods. The volumes yielded by the methods employed were in the following order of merit :—1. the Trenner Lee retort, 2. Trillat's autoclave, 3. the potassium permanganate process, 4. the sheet spraying method, and 5. the Kuhn lamp. For simplicity M. Base considered that the potassium permanganate process was preferable to all the others. It should be used in the proportion of 300 grammes of the salt to 600 c.c. of formalin. Trillat's autoclave, although it did not give such a high percentage of gas, has an advantage in that a uniform quantity is kept up for a long time. The Kuhn lamp yields a low amount of gas but possesses the merit of producing more moisture in the air of the room than the other methods : a point of value, as it is preferable to nearly saturate the air of the room with moisture in order to favour the condensation of moisture formaldehyde on the various articles. He further lays down the practical requirements for effective disinfection by formaldehyde:—(1) Five grammes of formaldehyde in each cubic metre of space, *i. e.*, 0·1416 gramme per cubic foot and (2) the temperature of the room should not be allowed to fall below 50° Fahr., the best temperature being 68° to 77° Fahr. The gas should be allowed to act for seven hours.

Mr. Clintic, experimenting in the disinfection of railway carriages with formaldehyde, arrived at the conclusion that very little formaldehyde was produced at temperatures below 60° Fahr. owing to polymerisation of the gas. A large quantity of gas assists penetration as do a high temperature and humidity, but even then, as its penetrative power is so little, it should not be used for articles requiring a high degree of penetration. For simplicity and rapidity he found the formalin permanganate process was the most efficient and more fatal to the Tubercle bacilli than any other method. He remarks however that the presence of water is unnecessary. Tubercle and coli communis, Diphtheria and Typhoid bacilli and Bacillus subtilis were all killed.

Chlorine is a gas extensively used for disinfection purpose, It is a heavy, very irritant gas, which destroys organic matter, bleaches organic pigments and destroys odours. It can be generated in many ways :—

(1) By heating a mixture of sodium chloride 8 parts, manganese dioxide 2 parts, sulphuric acid 2 parts and water 2 parts, per thousand cubic feet of air space.

(2) By acting on manganese dioxide with hydrochloric acid.

(3) By mixing bleaching powder and strong sulphuric acid in the proportion of 1½ pounds of the former to 6 ounces of the latter for each 1,000 cubic feet of air space. The reaction which follows results in the formation of calcium

sulphate and hydrochloric and hypochlorous acid. These two latter interact and form chlorine and water. The reaction can be represented thus—

$$\begin{aligned}
&C\mathit{a}Cl_2O_2 &+\ & H_2SO_4 &=\ & C\mathit{a}SO_4 &+\ & 2HClO. \\
&C\mathit{a}Cl_2 &+\ & H_2SO &=\ & C\mathit{a}SO_4 &+\ & 2HCl. \\
&HCl &+\ & HClO &=\ & H_2O &+\ & Cl_2.
\end{aligned}$$

The acid acts at first only on the hypochlorite giving a sulphate and hypochlorous acid, but if enough be added the chloride also is attacked giving sulphate and hydrochloric acid.

Carbonic acid acts only on the hypochlorite giving a carbonate and hypochlorous acid and this, in contact with organic matter, splits up into hydrochloric acid and oxygen.

$$C\mathit{a}\ (ClO)_2 + CO_2 + H_2O = C\mathit{a}CO_3 + 2HClO.$$

Delepine strongly recommends that walls, ceiling and floors be brushed with a solution of bleaching powder of a strength of 1 in 100 to ensure more certain contact. Further, the activity of this solution may be increased by adding a little acid to the solution or by having acid fumes in the air and raising the temperature. The mixture is used in the proportion of two ounces of bleaching powder to one pint of water. The difficulty in regard to this very valuable disinfectant is that in a hot climate it is apt to deteriorate and lose its power of destroying microbes. Hankin of Agra states that specimens having a coarse granular powder keep longer than other specimens in which the material forms adherent masses, and summarises a series of experiments thus:—

1. Chloride of lime, *i.e.*, bleaching powder, when fit for use has a strong smell of chlorine. If kept in a hot climate, the amount of available chlorine will be about one-third of the original in about three months, after which time the amount of chlorine may be less, and the lime will then be unfit for use.

2. Chloride of lime is readily attacked by various kinds of organic matter. It is therefore unsuitable for dealing with sewage or other large masses of putrefying matter. On the other hand, it may be used with advantage in places where the infective material can only be imbedded in small amounts of organic matter.

3. Owing to its deodorant properties and penetrative powers, it may be used in the interior of infected houses, both on the walls, on furniture, or on floors either concrete or cement.

4. Owing to the high bactericidal powers of chloride of lime, under circumstances in which its action is not masked by the presence of an excess of organic matter, it is likely that it could be useful in cleansing and disinfecting wells, either in place of or in combination with permanganate of potassium ; if used for this purpose, the water should be pumped out before the well is passed for use again.

Chloride of lime itself is usually made by passing chlorine gas over slaked lime,

$$2Ca\ (OH)_2 + 2Cl_2 = CaCl_2 + Ca(ClO)_2 + 2H_2O.$$

Good bleaching powder should contain at least 33 per cent. of available chlorine.

It must be noted that chlorine acts much better when the air is moist, and, as the gas is heavy, it should be generated in an elevated position. The method so long advocated by Professor Delepine is the routine one in force in the City of Manchester for disinfecting houses, and experiments have proved its great reliability, provided that the chloride of lime is up to proper strength. This is the great difficulty in hot countries, but where a constant supply of comparatively fresh material can be obtained, there is no reason why this method should be less successful here than in colder climates. It, moreover, has the great advantage of being very cheap.

Producer Gas.

Producer gas consists of carbon monoxide 8%, nitrogen about 70 % and some carbon dioxide. It is generated by blowing a current of air into a producer in which coke is burned. Part of the heat generated is used in a boiler for raising steam, which serves to operate a water pump and a ventilating fan. The pump supplies the water necessary for cleaning and cooling the gas, while the fan forces in the air necessary for the combustion of the coke. The plant not only introduces the gas it generates, but also removes it from the hold after the operation is complete. To effect this either fresh air is forced in or the foul air is drawn out. The carbon monoxide, while failing to kill mosquitoes and bugs, kills rats. In Hamburg a special plant is provided which enables the producer gas to be mixed with formaldehyde vapour, which can at any time be connected or disconnected. By this means a disinfecting action is produced as well, as the formaldehyde, while sparing rats and mosquitoes, destroys bacteria. The effluent produced in making and purifying this gas is of a highly offensive nature, containing as it does sulphurretted hydrogen in considerable quantities. The discharge of the effluent into the public sewers should be prohibited, unless measures be taken to eliminate the odour of the sulphurretted hydrogen. This can be done by the addition of potassium permanganate to the washings in a settling tank. The cost of this process works out at about £ 2,500 for the large floating plant which may be mounted on a small barge, and if, say, 100 vessels be treated in a year the cost comes to about £ 3 to £ 4 per ship, including interest coke and labour.

LIQUID DISINFECTANTS.

Very many liquid disinfectants have from time to time been placed on the market. Among the more commonly used ones in India are—

(1) *Mercuric Chloride.*—It is readily soluble in water and alcohol. It is very poisonous, corrodes metals and coagulates albumin. As a disinfectant it is very powerful and in a strength of 1 in 1,000 will kill Anthrax, Enteric and Diphtheria bacilli. For spores a strength of 1 in 500 is required. Its solution is colourless, and as it is so very poisonous it should be artificially coloured, aniline blue being most often used for the purpose. It has no smell and is comparatively harmless to insect life. As it is non-volatile it is used purely as a local disinfectant. Its antiseptic power is said to be increased by the addition of ½ % of hydrochloric acid.

As a disinfectant for urine, it is not so very efficacious, as the salts in urine give up chlorides which unite with the mercury. So also as a disinfectant for sputum and fæces it is not of so much value, because an insoluble albuminate of mercury is formed and the organisms protected from contact with the fluid. It is largely used in France in the form of a spray for rooms in a strength of mercuric chloride 1 part, acid tartaric 3 parts and water 500 parts.

Mercuric Iodide is insoluble in water, but is soluble in an excess of potassium iodide. It is less poisonous than the chloride, and is stated to be twice as strong. For floors a solution of 1 in 4,000 is used.

Mercuric Cyanide is as powerful as the chloride and has the advantage of not being precipitated by albumin, gelatin, mucin or organic matters, and is therefore better adapted for mud floors smeared with cowdung. It is somewhat expensive, however. Used with kerosine oil emulsion in a strength of 1 in 50, it makes a good disinfectant for Plague houses.

Carbolic Acid is prepared from tar distillates, and in the crude state is a dark, oily liquid. Pure phenyle forms colourless crystals turning red in the light. It is soluble in water to the extent of about 1 in 15. Its action is uncertain and even in a strength of 1 in 20 it cannot be relied upon to kill all organisms, nor does it kill the spores of Anthrax. It is piosonous, expensive, readily absorbed by the skin and abrasions.

Izal is extracted from an oil obtained in the process of carbonising coke in close ovens. In water it forms a creamy emulsion. It is non-poisonous and has no caustic action on the skin. It mixes readily with water in all proportions. Klein found that a solution of 1 in 500 completely disinfected Typhoid stools in 15 minutes. A solution of 1 in 600 renders Typhoid urine aseptic in 5 minutes. A strength of 1 in 200 kills the organisms of Diphtheria, Typhoid, Cholera and Erysipelas in 5 minutes. Not being volatile it is strictly local in its action. It does not injure textile articles to which it is applied and its odour is non-irritating. A ten per cent. solution kills Anthrax spores in 20 minutes. It is used in solutions of 1 in 50 for sputum, and 1 in 100 for rooms and for the wet dusting of furniture. Used in the strength of 1 in 100, it is a good disinfectant for the various infectious diseases.

Lysol is mixable with water in all proportions. It is a brown, transparent, soapy liquid and is said to be practically non-poisonous. Its mode of preparation would appear to make its use, as a general disinfectant on a large scale, impracticable on account of expense. For surgical purposes it is valuable.

Cyllin is a cheap, powerful disinfectant and pulicide. It is easily mixable with water, does not corrode metals, nor does it injure ordinary clothing. It is non-volatile and non-irritating and does not damage wall papers, nor leave any objectionable odour in the room. It can be used in the form of a spray or as a wash. Most frequently it is used in two strengths, *viz.*, for sputum, blood, fæces and for mud floors, walls, cowdung floors, vomitted matters, etc., it is used in the proportion of two ounces to two gallons of water, *i.e.*, 1 in 160, and for latrines, drains, clothing, furniture, ceilings, etc., in the strength of one ounce to two gallons of water, *i.e.*, 1 in 320.

Equal parts of cyllin and petrol mixed with water form an excellent bactericide and pulicide.

Formalin in a one per cent. solution is frequently used as a spray. It is cheap, rapid and reliable, but has an irritating odour and affects the eyes. It is harmless to most metals, except iron, and does not affect colours.

SOLID DISINFECTANTS.

Very many varieties are sold. It is to be regretted, however, that their use is generally mis-applied for reasons which have already been referred to. The most frequently used ones are lime, chloride of lime, potassium permanganate, carbolic powder and ferrous sulphate.

Lime—Burnt lime is good and cheap, but it must be fresh.

Chloride of Lime—Although included among the solid disinfectants, it is usually used as a liquid disinfectant and is a most valuable one. It is obtained by passing chlorine gas over moist, slaked lime. On solution in water it breaks up into chloride and hypochlorite ; the latter is strongly alkaline and is acted upon by the carbon dioxide of the air giving carbonate of lime and hypochlorous acid, and this latter in contact with organic matter splits up into hydrochloric acid and oxygen and it is on this that the action depends. Delepine advocates a process which has for years past been pursued in Manchester for disinfecting rooms occupied by Tuberculous patients. The walls, ceiling and woodwork are carefully rubbed down with dough to collect the superficial dust and then a solution of chlorinated lime (1-100) is painted on the surface two or three times. The room is then closed and water containing a little hydrochloric acid is evaporated over a small stove. Three hours suffice for the process. The solution recommended is six ounces of powder to three pints of water. Chloride of lime possesses an irritating odour. It corrodes metals. It should contain at least 33% of available chlorine. The workmen must leave the room while the actual process is going on.

Permanganate of Potassium is most frequently used as a deodorant. It is expensive, it stains clothing and is easily rendered inert in the presence of organic matter. In India it is chiefly used in disinfection of wells ; it has been dealt with in that connection.

Ferrous Sulphate acts by its reducing action. Unless in strong solution it acts but feebly. It is a good deodorant. It is used sometimes for disinfecting excreta.

PULICIDES.

As will readily be imagined, rats, bugs, lice and fleas may often exist in places which do not permit of the application of disinfectants or pulicides directly. One would therefore naturally fall back on gaseous disinfectants as a means of combating these vermin. In ships and well-constructed houses such agents may be very successful, but, as has already been explained, in the majority of Indian houses such methods are inapplicable. This fact has been well exemplified by Captain Gloster, I.M.S.

One must therefore employ an agent other than gaseous.

Saigol, after a series of experiments dismissed as useless, perchloride of mercury, potassium permanganate, formalin, tar, lime, washing soda, sulphuric acid and many other substances. On the other hand, he considered as valuable phenyle, cyllin and izal, and of these phenyle to be the best. Sommerville states that rat fleas are killed by cyllin 1 in 400, phenyle 1 in 250 and Jeye's fluid 1 in 250, but adds that he would not rely on the application of any disinfectant for this work for less period than 5 minutes.

In Bombay City *Pesterine* is the official pulicide. It is applied to the floor and walls by the aid of a brush. It is the crude petroleum (liquid fuel) and in appearance resembles thin coal tar. It is incapable of direct mixture with water, but by the use of soap solution it can be converted into a fluid perfectly mixable with water in all proportions, in which form it is very efficient against fleas, etc. Pesterine and cyllin in equal proportions when mixed and added to 100 times the volume of water give a valuable emulsion of pulicidal value. It can either be sprayed or applied directly to floors or walls. In its crude state pesterine unfortunately fouls surfaces to which it is applied and consequently it is open to objection for use in better class houses. In its favour, however, is the fact that it is cheap, easy to apply and very efficient as a pulicide and further, what is a feature of very great importance, it is not likely to be diverted to other uses. The staff who do the disinfection should wear long coats and protect their feet with shoes or *chuppals* (sandals), and begin operations with sprinkling a little pesterine on the floor. They should then remove all the furniture, etc., and should any fleas be dislodged by this process they will fall into the pesterine already on the floor.

After the room has been emptied, they should spread the pesterine with a long brush over the walls, carefully going over all the nooks and cracks and ledges ; this can be quickly done if the brush is held horizontal. A little more pesterine should now be sprinkled over the floor and by means of a broom spread all over in an even manner. Finally, a small quantity should be poured into any rat hole found in the floor. Pesterine may also be used to kill the larvæ of flies and mosquitoes and other insects.

Petrol and heavy *benzine* obtained from crude petroleum prove fatal to fleas on mere contact, and the fumes also kil in about one minute. Emulsified with cyllin or phenyle, no separation of oily particles takes place on the addition of water, and there is no objectionable odour. Though both cyllin and phenyle emulsify petrol, the former is preferable owing to its greater germicidal power. The emulsion must be made fresh immediately before use It is made thus: thoroughly mix cyllin or phenyle with an equal quantity of petrol or benzine and then gradually add water, little by little, shaking vigorously until the two appear thoroughly and uniformly mixed. Slight liberation of gas may occur at this stage. This emulsion diluted to 1 in 800, *i. e.*, in 1,600 of either will kill fleas quite successfully.

A mixture of petrol, benzine and crude petroleum, (or 1 : 2 : 3 mixture) also acts as an efficient pulicidal agent. It is made by taking the chemicals in the above proportions and then gradually adding water to the desired extent. Actual contact with the fluid appears to be necessary to kill fleas and the females appear to be the more resistent.

Refined oil emulsion used in dilution of 1 in 10 appears to kill all fleas that come in contact with it. To make this emulsion, take four cakes of sunlight soap, slice them and add ½ gallon of water and boil till the soap dissolves. Now place in an open tub and beat up the solution, gradually adding the oil at intervals of one minute, seeing that all trace of free oil is absorbed into the frothy mass before fresh is added; after adding 3 gallons of oil go very carefully. If properly done, ½ gallon of soap solution should emulsify a whole tin of kerosine oil (4 gallons). The time taken to make such a brew is generally about half an hour.

Captain Gloster, I.M.S., recommends an emulsion of kerosine oil made thus :—Take sunlight soap 3 parts and boil in water 15 parts. To this add kerosine oil 100 parts shaking and stirring the while. The oil should be warmed carefully before being added. Fleas in a test tube were killed in 2 minutes by a 1 in 1,000 dilution of this emulsion For earthen floors the emlusion should be used in a strength of 1 in 20 of water. This emulsion has no bactericidal powers. Another recommended by the same observer is

Hydrocarbon Emulsion.—Hydrocarbon is a bye-product in the manufacture of gas from kerosine oil . The emulsion is made in the same manner as the former, except that the hydrocarbon does not require any preliminary heating. The emulsion mixes well with water and has a bactericidal action twice as great as that of carbolic acid.

Kerosine oil and cyanide of mercury, in the proportion of 2 of the latter to 100 parts of the former, form an excellent preparation for native houses. It is, however, somewhat expensive.

Sunshine as a Pulicide.—In a Plague-infected country, such as India, of vast dimensions and possessing comparatively few large cities and towns, circumstances must repeatedly arise daily where it is desirable to take precautions in regard to the conveyance of infected fleas in the personal clothing and bedding of travellers.

Large numbers of people are continually passing from the towns to the villages, and it is obviously impracticable to suggest steam disinfection of clothing, etc. on arrival, and in many cases even treatment with one or other of the various pulicides mentioned above is out of the question.

To meet this obvious difficulty experiments were conducted at Bombay Bacteriological Laboratory by Captain Cunningham, I.M.S., to test the efficacy of sunshine as a pulicide, and most valuable results were obtained : valuable in that it is now known that precautionary measures can be carried out in practically every village in India, however remote from towns, at no expenditure of money and with but little labour. Certain essential precautions of a very simple nature have to be observed, however, and these have been fully detailed by Captain Cunningham and may be summarised as under :—

(1) Choose a smooth, sandy place where no grass or bushes grow, and which is fully exposed to the sun. It must not be near trees or houses and the ground should have no cracks in it and be free from stones.

(2) If the place is not sandy by nature, it must be covered with a layer of sand three inches deep and made quite smooth on the top.

The sand must be very hot before the clothes are put on it. It is necessary, therefore, to wait till about 10 a. m. before spreading the clothes and no clothes should be spread after 4 p.m., as the sand will not be sufficiently hot at that hour.

The clothes should be spread evenly on the sand in a single layer and allowed to remain in the sun for the period of one hour.

(3) Thick and padded clothes, such as *resais* and quilted coats, must be turned over once or twice in order to expose both surfaces to the sun.

(4) Clothes must not be placed within three feet of the edge of the sand, as otherwise some fleas may escape and ultimately reach the village.

(5) The sandy surface must be quite smooth and precautions should be taken to prevent cattle straying across the prepared surface prior to the commencement of operations.

It will be seen that this simple precautionary measure is within the reach of any one in any place and practically at any season, and it cannot be too widely known and acted upon by all village authorities in respect of travellers from known Plague-infected centres.

Disinfection of Excreta and Discharges.

In certain diseases this is a most essential duty, *e.g.*, the urine and bowel discharges in Typhoid, the sputum in Phthisis and Lobar and Plague Pneumonia, the discharges from the throat and ears in Scarlet Fever and Diphtheria and the discharges from the nose, the vomitted matter and fæces in a case of Cholera, etc., etc. For this purpose there is a large choice of disinfectants. One may use izal 5% or acid carbolic 10 per cent., chinosol 1 in 500, cyllin 1 in 160. The whole should be well mixed and allowed to stand for 1 to 3 hours and then discharged into the sewer, or failing a sewer, buried deep well away from any source of water supply or risk of contamination thereof. For Cholera dejecta equal parts of quick lime and water may be mixed, and this slake so formed may be diluted with three times as much water as was formerly used. Now equal parts of this mixture and the Cholera dejecta should be well mixed and allowed to stand for one hour, after which the vibrios will be dead. Similarly, good chlorinated lime in the proportion of two tablespoonsful to a pint of Cholera dejecta is effective in 20 minutes. For Typhoid bacilluria one per cent. formalin solution is effective. Great care must be taken in destroying all discharges from the mouth, nose, throat or lungs and ears of persons suffering from Scarlet Fever, Diphtheria, Whooping Cough, Measles, Small-pox and Cerebro-spinal Meningitis. These can be destroyed by fire or by chemical disinfectants. In some places the fæces, etc., are sterilised by steam or boiling and after cooling are discharged into the drains.

The disinfection of sputum in the case of Phthisical patients and Pneumonia cases is of the utmost importance. In isolated cases the use of izal solution is quite satisfactory, but in the case of a large institution set apart for consumptives, where in all probability there is a steam laundry, etc., working in the institution, a more satisfactory method of disposal would be by steam, which is already available. Goddard, Massey and Warner have introduced for the purpose an apparatus for which they claim the following :—

The apparatus consists of a steam chamber, with galvanised baskets for receiving the sputum mugs, "pocket" bottles or jars, which are used by the patients under treatment.

These vessels when containing sputum are placed into the baskets for disinfection, the receiving door of the apparatus is then closed and the whole contents are subjected to a temperature of 126 degrees Centigrade ; the process of disinfection is allowed to remain in operation for a few minutes after which the cylinder carrying the galvanised baskets is revolved, by which action the disinfected sputum empties itself into the bottom of the disinfector, and is then discharged under pressure into the sewer or drain. Hot water is then admitted into the chamber for cleansing the inside of the chamber, baskets, mugs, bottles, etc., the cylinder again revolved, and when the cleansing process has proceeded for a short time, the hot water is run off into the sewer, and the whole of the contents are ready for use again.

With this apparatus three very important results are obtained :—

1st—The treatment of disinfecting Phthisical sputa, all the germs being thoroughly sterile after the process ; therefore the liquid is free from infection, and may be run direct into the sewer or drain, without fear of infection.

2nd—No germs of Phthisical disease adhere to the vessels being used again, as the mugs and vessels themselves are subjected to thorough disinfection. The vessels used by the patients are ready for use again, after being taken out of the machine perfectly clean, without the use of any separate cleansing, and thus the nauseous and dangerous process usually adopted at the present time is avoided.

3rd—The process of disinfection is easily performed, the whole operation only taking a few minutes therefore the expectorations contained in the vessels used by the patients between each meal hour may be disinfected three times a day, at very little trouble to the attendant.

DISINFECTION OF THE HOUSE.

The choice of method depends largely on the character of the house to be disinfected and on the nature of the disease for which disinfection is required. In the absence of any contra-indication a gaseous disinfectant can be used, either formalin, chlorine, or sulphur. Should, however, obvious impediments exist to the use of such, then sprays or washes may be employed, *e. g.*, perchloride of mercury in a strength of 1 in 1,000 ; or formalin, strength 4 ounces to 1 gallon, or chloride of lime as a wash using a solution of the strength of 2 ounces to the pint of water. There are many forms of sprays on the market, *e. g.*, Defries', Mackenzie's, or Robertson's. When the disease is spread by insects, *e.g.*, fleas or bugs, and gaseous disinfectant cannot be used, then one or other of the pulicidal emulsions mentioned may be employed.

Whatever agent is chosen and in whatever form it is applied it is most important that no part of the house be overlooked. The staircase, privies and washing places must all be done. If cloth ceilings exist, they should be removed and a careful search made for rat's nests ; so also every accumulation of lumber must be removed and any rats found destroyed.

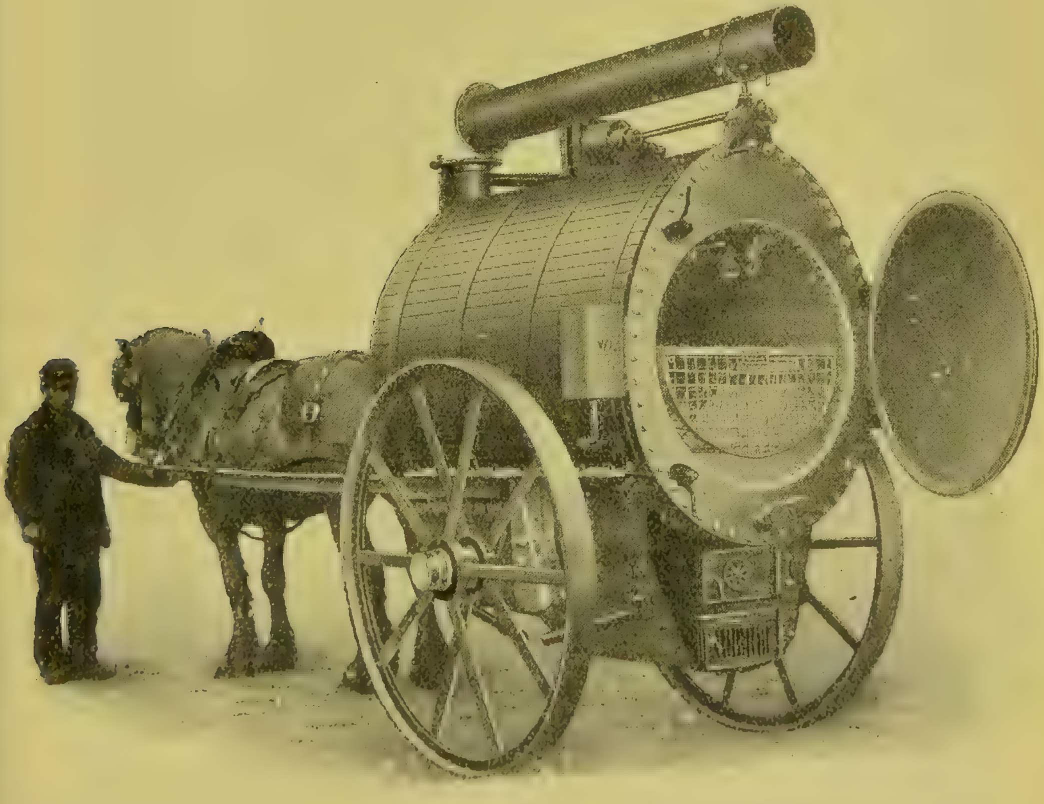
The furniture must be disinfected, horse-hair or leather articles may be washed or sprayed with formalin solution or perchloride of mercury. All articles of wood should be washed with soap and water, and in the case of wooden bedsteads, tables and chairs pulicides can be freely used.

All cooking and eating utensils of whatever nature must be carefully washed with soap and water and subsequently with izal or other suitable disinfectant in those cases, where infection is likely to be conveyed by means of articles of food or drink.

DISINFECTION OF THE CLOTHING.

All clothing and bedding which has been exposed even remotely to infection must be collected and a duplicate list thereof made ; one copy is to be given to the householder and the other retained by the Inspector. Should any clothing or bedding be in a damaged condition, careful note should be recorded of the fact. Concealment of infected clothing must be guarded against. When collected, the articles should be removed to the disinfection station in a covered vehicle before the disinfection of the house is commenced. At the station they are disinfected by steam, when such an agent is permissible. In some towns blankets are not subjected to steam on account of the tendency of that agent to alter their texture and colour, but instead they are placed in a disinfectant fluid. Articles of but little value may be destroyed after obtaining the owner's consent in writing. After disinfection, the clothing, etc., is brought back in a vehicle which must always be reserved for disinfected clothing only. The Inspector should obtain a receipt from the owner for the return of the clothing and also a statement as to the condition in which it has been returned : any neglect of this precaution may result in claims for damages, imaginary or real, being sent in at a later date. This, therefore, should never be omitted.

Boots and other leather goods, furs, rubber goods, silks, brushes, combs and feathers may be removed to the station and there treated with formalin vapour or a spray of perchloride of 1 in 500 or formalin 2 per cent. Books, if of little value, may, by consent of the owner, be burned; but if it is desired to retain them, then, they can be treated with formalin vapour. This is usually carried out in a cupboard compartment, in which books are disposed on shelves of perforated zinc gauze in such a manner that the pages are opened out, or the books may be suspended on wires from the top of the chamber. Fumigation should be carried out for two or three hours. Kister and Trautman recommend a method which is carried out as follows: the books are placed in a steam disinfecting apparatus fitted with a vacuum producing arrangement, formalin is placed in a vaporiser at a point in the oven most distant from the vacuum apparatus, and as the pressure inside the oven is reduced, formic aldehyde and steam are liberated at about 80° C : this is continuously sucked through the apparatus for thirty minutes, the books being disposed in the track of the vapours.



THE PORTABLE DISINFECTOR.

In districts where no public disinfecting stations exist, disinfection may be carried out by means of portable small disinfectors (steam), which visit the houses where the process is to be carried out. If no such disinfection is available, other measures must be adopted. Matresses if badly soiled should be burned, sheets should be soaked in izal 5 per cent., carbolic acid 5 per cent. or cyllin 1 in 320 for 1 to 2 hours, and then boiled and washed in soap and water.

Personal underclothing may be similarly treated. Other articles of clothing may be exposed to formalin vapour or spray. Washing suits should be placed in one or other of the above disinfecting solutions, subsequently boiled and then exposed to the sunlight. Blankets should not be boiled.

Leather goods, furs and feathers may be disinfected by means of a spray of formalin, perchloride of mercury 1 in 500, or a 2 per cent. solution of formic aldehyde.

Inspectors in charge of disinfecting plants should exercise great vigilance in seeing that the correct temperature is maintained and that sterilised articles are not allowed to re-enter the room reserved for infected articles. For this reason most sterilisers have two doors opening into separate rooms and these rooms must never be considered to be interchangeable, and there should be no direct communication between them. Further, separate vans must be kept for infected and disinfected articles. A mistake to be carefully guarded against is the habit of packing too many articles in the apparatus at one time, with the result that some of the articles are so closely wedged that it is practically impossible for the steam to penetrate the interstices, with the result that disinfection is not accomplished; the articles should be comparatively loosely packed. If, for one reason or another, the Inspector on visiting a house is not able to wait for the arrival of the disinfecting gang, or the infected clothing van, he should arrange for a preliminary disinfection of the clothing on the spot. For this purpose he should carry perchloride of mercury tablets and personally see that such articles as sheets, handkerchiefs, night-clothes, etc., which have been soiled, are immersed in a solution of this disinfectant, while awaiting the arrival of the van. In the presence of a serious epidemic of Cholera, etc., this is a valuable safeguard, as it lessens the chances of the articles being handled by the inmates and also of flies becoming the means of disseminating the disease, as, if the outbreak is of serious extent, many hours must of necessity elapse before the van arrives. A further point, which should never be omitted, is to see whether a well exists on the premises; if so, and the disease is a water-borne one, precautionary disinfection of the well should be done by one or other of the methods described in the section dealing with water. Disinfection of the water taps also should be carried out as a routine practice, since infected clothing is frequently placed on one tap while washing is carried out at another.

In regard to the privies, the Inspector should see that not only the seat, floor and walls are disinfected, but also, if the privy be of the common basket type,the receptacle and its contents, if the disease for which disinfection is being carried out is one in which the excreta are likely to convey infection, *e.g.* Cholera, Typhoid, etc. By this means the risk of conveyance by the agency of flies is lessened. Izal 1 in 20, carbolic acid 1 in 10, or cyllin 1 in 160 may be used for the purpose. This is an important point which should never be overlooked. Finally, the Inspector in carrying out disinfection of a house should always exercise tact and discretion, remembering that at the best the process is one which involves some degree of discomfort to the occupants. He should see that no wanton damage is done and, as far as possible, study the convenience of the occupants, never, however, permitting this to conduce to an imperfect disinfection. Very often a few words, indicative of his object and the scope of his intended operations, will serve to allay any spirit of opposition that may be evinced and should it not do so, the Inspector has always the support of the law to fall back upon. This he should not put in force himself, but report to his superior officer and await further instructions.

Sanitary provisions of the City of Bombay Municipal Act in respect of Disinfection.

Section

425. (1) If the Commissioner is of opinion that the cleansing or disinfecting of a building, or of a part of a

building, or of any article therein likely to retain infection, would tend to prevent or check the spread of any dangerous disease, he may by written notice require the owner or occupier of such building to cleanse or disinfect such building or part thereof or article therein; and, if it shall appear to the Commissioner necessary, to vacate the said building for such time as shall be prescribed in the said notice:

(2) Provided that if, in the opinion of the Commissioner, the owner is from poverty or other cause unable to effectually comply with such requisition, the Commissioner may cause the building or part of the building or article likely to retain infection to be cleansed or disinfected and defray the cost of so doing.

427. (1) The Commissioner may provide a place, with all necessary apparatus and attendance, for the disinfection of clothing, bedding or other articles which have become infected, and in his discretion may have articles, brought to such place for disinfection, disinfected on payment of such fees as he may from time to time fix, with the approval of the Standing Committee, in this behalf, or, in any case in which he thinks fit, free of charge.

(2) The Commissioner may, from time to time, by public notice appoint a place at which clothing, bedding or other articles which have been exposed to infection from any dangerous disease may be washed; and no person shall wash any such article at any place not so appointed without having previously disinfected the same.

(3) The Commissioner may direct the disinfection or destruction of bedding, clothing or other articles likely to retain infection.

(4) The Commissioner may, in his discretion, give compensation for any article destroyed under subsection (3).

431. The owner, driver or person in charge of a public conveyance, in which any person who is suffering from a dangerous disease has been carried, shall immediately provide for the disinfection of the same.

432. (1) No person shall, without previous disinfection of the same, give, lend, sell, transmit or otherwise dispose of any article which he knows, or has reason to know, has been exposed to infection from any dangerous disease.

(2) Nothing in this section shall be deemed to apply to a person who transmits, with proper precautions, any such article for the purpose of having the same disinfected.

433. (1) No person shall let a building or any part of a building, in which he knows or has reason to know that a person has been suffering from a dangerous infectious disease, without first having such building or part thereof and every article therein likely to retain infection disinfected, to the satisfaction of the Executive Health Officer or of some duly qualified medical practitioner, testified by such officer's or medical practitioner's certificate.

(2) For the purpose of this section, the keeper of a hotel or inn shall be deemed to let a part of his building to any person accommodated in such hotel or inn.

Special Sanitary Measures.

434. (1) In the event of the city being at any time visited or threatened with an outbreak of any dangerous disease, or in the event of any infectious disease breaking out or being likely to be introduced into the city amongst cattle, including in this expression sheep and goats, the Commissioner, if he thinks the ordinary provisions of this Act, or of any other law at the time in force are insufficient for the purpose, may with the sanction of Government—

(*a*) take such special measures, and

(*b*) by public notice prescribe such temporary regulations to be observed by the public or by any person or class of persons, as he shall deem necessary to prevent the outbreak of such disease or the spread thereof.

(2) The Commissioner shall forthwith report to the Corporation any measures taken and any regulations prescribed by him under sub-section (1).

INSTRUCTIONS TO THE DISINFECTING STAFF IN BOMBAY.

Disinfection for Cholera.

1. Inspectors must ascertain in every case whether all the personal clothing worn by the patient and all the bedding and any article of attire, which may have been soiled by vomitted matter or fæcal discharge, has been collected and dealt with by the District Registrar or his staff on his preliminary visit. The District Registrar has instructions to immerse all such articles in *perchloride solution* pending the arrival of the disinfecting staff. The Disinfecting Sub-Inspector must remove all infected clothing for steam sterilization.

N.B.—It is of the utmost importance that no infected article be overlooked, and it will be considered a very serious neglect of duty if any instance of such is detected.

2. *All water taps* must be carefully washed with freshly prepared permanganate solution and the water allowed to flow freely for a few minutes afterwards.

3. Careful search must be made to see if *any well* exists in the premises ; if so, it must be treated with permanganate solution.

(*N. B.*—A solution of the crystals must be made first and be added to the well water till the latter remains pinked for about half an hour.)

4. *Every privy seat* should be carefully scrubbed with a brush, using plenty of water with some *izal solution* in it. The walls and floor of the privy must also be well washed with the same solution. If necessary, *pesterine may be applied subsequently.*

5. As far as possible all drinking utensils, plates, knives, &c., and all chatties should be well washed in a *solution of izal* and subsequently washed in clean tap water.

6. *The rooms* should be carefully swept (after removing all furniture) and then *disinfected with perchloride solution or izal.* The furniture should be well rubbed with a cloth soaked in izal solution, and any table or article of furniture that will permit washing should be so treated.

7. The members of the family should be informed that it is essential to observe the greatest strictness in regard to cleanliness of their hands and utensils when taking food. All excreta from patients must be treated with the disinfectant supplied.

8. The privy bed and receptacle and also the trap door, if present, and the walls should be most carefully cleansed under the personal supervision of the Sub-Inspector. After thorough cleansing, the whole trap should be treated with pesterine. The object of so doing is to lessen the risk of conveyance of the disease by the agency of flies ; and it is most important that the work be carried out in a conscientious and thorough manner. This procedure must be carried out in the case of Typhoid Fever also. Printed instructions on the prevention of the disease should be given to the relatives.

Disinfection for Typhoid or Enteric Fever.

Typhoid Fever or *Enteric Fever* is conveyed by the ingestion of some article of food or drink, which has become infected with the Typhoid bacillus. Water, milk, vegetable, shell-fish, ice-cream, etc., etc., may all serve as media for the bacillus to retain its infective character. Flies have been proved to convey the germs of Enteric and other diseases to food, and a frequent source of contamination is the eating of food without preliminary washing of the hands after contact with a patient suffering from Typhoid or with infected clothing.

It is most important therefore that the Inspector should faithfully carry out the following rules :—

1. All infected or soiled personal linen, etc., and bad clothes should be at once placed in a solution of izal fluid 1 to 200 and allowed to remain there until the disinfection of the house is completed.

On completion, the clothes should be removed to the van and taken to the steam sterilizer.

2. The mattress (if any) should be removed to the steam sterilizer.
3. The walls, floor, door and seat of the privy should be thoroughly washed with izal solution. This must be done most carefully and thoroughly, as the risk of infection being conveyed in this way is considerable.
4. It is specially important that all utensils used by the patient for eating or drinking should be thoroughly washed in izal fluid and then in pure clean water.
5. The walls, doors, floor and ceiling of the room or rooms should be washed with perchloride of mercury solution, or izal, care being taken to prevent dust rising and thereby increasing the risk of the disinfecting gang contracting the disease.
6. All water taps should be carefully washed with freshly prepared permanganate solution and the water allowed to flow freely for a few minutes afterwards.
7. Careful search should be made to see if any well exists on the premises. If so, then it must thoroughly be treated with permanganate of potash solution.
8. If the privy is on the basket system, the Disinfecting Sub-Inspector must make arrangements for the complete disinfection of the iron receptacle with izal and the thorough cleansing of the privy trap and trap door. This should be done under his personal supervision to lessen the risk of conveyance of infection by flies. After thorough cleansing, the whole trap should be treated with pesterine.

N.B.—This procedure must be carried out in the case of disinfection for Cholera also. Printed instructions should be given to the relatives.

Supplementary Order.

As there still appears to be some doubt about the procedure in regard to disinfection of the clothing of Cholera patients, the attention of the District Registrars is once more drawn to the necessity of their carrying small bottles of perchloride tabloids with them. (An empty Burroughs and Welcome quinine bottle is handy and compact in which to carry them.)

On reaching the patient's house, all infected clothing should be *immersed* in a solution of perchloride, *not* sprinkled with it. This is merely to safeguard against the spread of infection, while waiting for the infected clothing van to come along and remove the clothes for steam disinfection. It is *not* meant to replace the latter. This must occur as usual.

Disinfection for Small-pox.

(See 'Disinfection by Sulphur Dioxide,' supra).

1. It is most important that every article of personal clothing and all bedding be very thoroughly disinfected. No article which has been in contact with the patient should be overlooked.

2. Any articles of furniture which can be washed should be thoroughly washed with soap and water and afterwards well rubbed with a cloth soaked in izal solution and finally rubbed with a dry and clean cloth.

3. All carpets, rugs, etc., should be removed to the steam sterilizer for disinfection.

4. The floor, walls, doors and ceiling should be well scrubbed, using a solution of perchloride of mercury or izal solution.

5. The privy seats, walls and doors should be well washed with water and then scrubbed with a brush, using perchloride of mercury solution or izal to disinfect with.

6. All utensils used by the patient for eating and drinking must be carefully washed in a solution of izal and subsequently in pure water.

7. The bedstead (if any has been used) should be disinfected as far as possible. If made of wood, then it should be wiped thoroughly with a cloth soaked in perchloride solution, if of iron, then izal solution should be used.

8. On no account should the keeping of the crusts of old Small-pox pustules be permitted. If found, the Inspector should at once destroy them by fire or by strong izal

solution. Contacts should be re-vaccinated and printed instructions should be given to relatives.

Disinfection for Phthisis.

As far as our present knowledge goes, the two main channels by which Phthisis is spread are (*i*) milk and (*ii*) the inhalation of infective dust containing Tubercle bacilli from the expectoration of an infected person.

In disinfecting for Phthisis, therefore, it is very important that as little dust be stirred up as possible.

1. All the walls, the ceiling and the floor should be carefully swept with a brush, round the end of which should be wrapped a cloth well soaked in perchloride solution. It is very necessary that this cloth be damp, as otherwise much dust will be disturbed and the risk of the disease being contracted by the staff thereby greatly increased.

2. Having removed the bulk of the dust in this manner, the wall, ceiling and the floor should be thoroughly disinfected by the application of perchloride solution or izal.

3. The furniture should be wiped over with a cloth soaked in perchloride or izal solution. Any article that can be washed without harm should be so dealt with.

4. Any handkerchief or rag, etc., soiled by expectoration should, with the consent of the owner, be destroyed by fire ; failing the necessary consent, the Inspector should disinfect it by izal solution first and subsequently by steam.

5. All personal clothing, bedding, etc., used by the patient should be removed at once for steam sterilization.

6. As privies are often fouled by expectoration,they should be carefully disinfected with izal solution and subsequently well flushed with water and finally pesterined. The floor, door, walls and seat should all be disinfected.

7. It is most important that no dust (in whatever position it may be in the room) be overlooked as the Tubercle bacillus, the active cause of the disease, will live for a long time in dust and is capable of spreading the disease.

Leaflets on the prevention of Tuberculosis should be given to relatives.

CHAPTER IX.

DANGEROUS, OFFENSIVE AND OTHER TRADES.

A Sanitary Inspector may at any time be called upon to submit a report on a particular trade proposed to be established, or perhaps already established. This necessitates that not only should he know the main processes the articles are subjected to, but also that he should possess a sound judgment and the power of accurate observation.

It may be, and in Bombay frequently it is the case, that a complaint in regard to an alleged offensive trade is based on personal animus or rivalry only, and has no foundation on fact; but however obvious it may appear to the Inspector that such is the case, he should in every instance go in and inspect the works and make sure from personal observation that there is no reasonable ground for complaint before dismissing the complaint as one due to personal feeling.

On the other hand, the Inspector must not be misled as to the true nature and results of any particular trade carried on in his own district by the absence of any complaints from residents in the vicinity, for, as pointed out by Ballard, several factors may account for the quiescence of such residents ; consequently, he must not regard absence of complaints as of necessity indicative of absence of nuisance. For instance, it may well be that the majority of residents in the neighbourhood of any suspected works are employed in those very works and refrain from complaining from fear of discharge on the information leaking out. The social position of the individual whose works are causing a nuisance may stave off complaint, so also may neighbourly feeling influence those most concerned. Further, it must be remembered that constant exposure to trade effluvia is apt to render them less sensitive to their influence, and, again, in a neighbourhood, where many works of a similar nature are carried on, it may be difficult for the person annoyed to definitely locate the source, and consequently he abstains from making complaint.

As a rule, the most offensive effluvia are those given off in processes in which the materials used consist mainly of animal matter, *e. g.*, the manufacture of artificial manures, gut cleaning and scraping, and the preparation of sausage skins and the melting of fat.

Certain processes dealing with vegetable substances can also be very objectionable, *e. g.*, the boiling of linseed oil, the manufacture of palmitic acid from cotton seed, foots and palm oil.

Ballard, in his report to the Local Government Board, points out that the extent to which trade nuisances spread and their degree of intensity are influenced by many factors. In regard to the first point, this may vary from a few yards to several miles, and is influenced chiefly by (1) the *nature of the effluvia.* If the effluvium consists of vapours of high density and but little diffusive capacity, it does not so readily travel to a distance, as would be the case if of less density and greater diffusive capacity ; but, at the same time, it must be remembered that the very fact of more ready diffusibility attenuates while also extending the area affected by the effluvium ; (2) *height of discharge of the effluvium.*—If near the ground level, nuisance is more likely to be caused in the immediate neighbourhood than at a distance ; (3) *nature of surroundings of the works.*—If this be open country, where there is perhaps nothing to impede the free passage of vapours, they may be a source of nuisance to people one or two miles away, even though the vapour be discharged close to ground level, whereas similar vapour similarly discharged in a town, or in a place where their free passage through the air is obstructed by buildings or other objects, may give offence only to persons residing within the limits of those buildings or other obstacle ; (4) *atmospheric conditions.*—The amount of moisture in the air and the force and direction of the wind and also the temperature of the air modify the distance to which effluvia will travel and their intensity. When the air is saturated with moisture and there is little or no wind, effluvia will hang about the immediate neighbourhood, even if discharged at some height. In clear weather, when there is little or no excess of moisture in the air, the effluvia will readily pass to a distance and be perceptible in the direction in which the air is moving. In a still atmosphere the effluvia, if discharged at a low level, hang and diffuse themselves about the works, but if discharged at a high elevation from a chimney they tend to rise to a still higher level with the heated column of air, and may there meet with a current of air which will drive them in some particular direction, and, before they finally reach ground level again, they have become greatly attenuated by diffusion and are therefore less likely to cause nuisance.

A steady, high wind, especially if moist, may carry effluvia in a more or less intense form to a considerable distance.

Atmospheric temperature also exercises an influence: effluvia, which originate in the decomposition of organic matters, arise much more readily and are more apt to make their presence felt in warm weather. In connection with trade effluvium-nuisances one of the most difficult questions to determine is to what extent, if any, such effluvia are injurious to health. If in connection with any trade the statement is made that it is a nuisance or injurious to health, it may mean, to quote Ballard again, "that exposure to the offensive "effluvia causes bodily discomfort or other functional disturbance, continuing or recurring as the exposure continues or recurs, and tending by continuance or repetition "to constitute, though perhaps not a clearly defined form "of disease, an appreciable impairment of general health "and strength. Such a definition is applicable to those "cases in which functional disturbances unquestionably "arise as the result of the impression made by the offensive "effluvia on the senses. The results may include loss of "appetite, nausea, vomitting, diarrhœa, headache, giddiness, faintness and a general sense of malaise and depression. Or, on the other hand, it may mean that persons "exposed to the effluvia are more deeply and permanently "damaged in health, that their lives are shortened or "pursued in chronic ailment, and that they are more liable "than other people to the invasion of definite forms of

" disease, or that diseases with them are liable to run a less " favourable course than with other people."

This definition includes deeper and more serious disturbance to health and includes workers in lead, phosphorus, arsenic, and those working in atmospheres largely charged with the vapours of sulphuretted hydrogen, chlorine and carbonic acid, or with the exhalations from decomposing organic matters.

Trade effluvia form an element of the atmospheric insalubrity of towns. Definite chemical substances, whose vapour is irritant or poisonous, are unquestionably dangerous and it is fallacious to impute disinfecting qualities to them. Effluvia of septic origin are unwholesome.

The interpretation of the word 'nuisance' has similarly given rise to much controversy.

CLASSIFICATION OF NUISANCES.

Nuisances in a legal sense are of two kinds : (1) *nuisances at common law,* and (2) *statutory nuisances.* Sanitary authorities are concerned with the latter variety only.

Winter Blythe defines a 'statutory nuisance' under the Public Health Acts as something which either actually injures or is likely to injure health, and admits of a remedy either by the individual whose act or omission caused the nuisance or by the local authority. As now read, the idea of a nuisance embraces future as well as present consequences.

At common law, a nuisance may be either *public* or *private,* or a mixture of both. Mr. Justice Stephens defines a 'public nuisance' as an act not warranted by law, or an omission to discharge a legal duty, which act or omission obstructs or causes inconvenience or damage to the public in the exercise of rights common to all His Majesty's subjects. A 'private nuisance' he defines as anything done to interfere with the proprietory rights of another in land not amounting to a trespass.

The London Public Health Act extends the definition of nuisance, making it include not only that which is injurious to health but also that which is dangerous to health.

As defined in Bombay Act III of 1888, a nuisance includes any act, omission, place or thing which causes, or is likely to cause, injury, danger, annoyance or offence to the sense of sight, smelling or hearing, or which is, or may be, dangerous to life or injurious to health or property.

Ballard in his report adopted a classification of the various trades which may give rise to nuisance or be dangerous to health, and that classification is the one most usually followed on account of its simplicity. It is as follows :—

(1) The keeping of animals. (2) The slaughtering of animals. (3) Branches of industry in which the matters dealt with are of (*a*) animal origin, (*b*) vegetable, (*c*) mineral, or (*d*) of mixed animal, vegetable and mineral origin.

In dealing with offensive trades, it may be considered that, should a nuisance arise, it is due to one or other of the following causes or to a combination thereof :—

1. The use of buildings unsuited structurally for the purpose.

2. An untidy or filthy condition of the premises and utensils.

3. An improper method of receiving or disposing of offensive materials used in the trade.

4. An improper mode of storing offensive materials or products.

5. Removal from the premises of filthy material in improper receptacles.

6. An escape of offensive gases or vapours generated during some part or parts of the processes carried on, and their passage into the atmosphere surrounding the works.

There are certain general principles of prevention of nuisances which are applicable more or less to all these trades, and to avoid needless repetition later on they may be stated at this stage.

1. Such structural and working arrangements should be made as will tend not only to prevent defilement but also assist cleansing, and those parts of the premises liable to

become dirty or encrusted with filth or decomposable matter and all utensils used in the trade must be regularly cleansed.

2. Offensive matters necessary for use in the business must be brought into the premises either in covered impervious vessels, or covered up in such a manner that they shall not be a source of effluvium-nuisance during transit. Offensive products should be similarly removed from the premises.

3. Offensive materials and products of the business should either be stored in impervious vessels, or in a closed chamber ventilated if necessary.

4. All filth should be collected in impervious covered vessels and removed from the premises daily.

5. Solid offensive matters should be separated from fluid as far as practicable, and each disposed of in its own appropriate manner, the solids being removed in covered vessels and the liquids being run into drains. Deodorants may sometimes be used with advantage.

6. Where the evolution of offensive gases or vapours is not avoidable, they must be intercepted in their passage to the external air and dealt with in such manner as to destroy their offensive character.

One method of interception consists in arrangements for drawing off in a continuous manner the air of the entire chamber or workshop in which the effluvia are evolved. When so drawn off or collected they may, according to their nature, be dealt with in one of the following methods :—

1. They may be discharged into the atmosphere at such an elevation as will ensure their being so dilute before reaching ground level again as to be comparatively inoffensive.

2. If the evolved matters be condensable by cold, they may be passed through an appropriate condensing apparatus.

3. If soluble in water or other liquid, they may be so treated.

4. Certain solid substances with which the effluvia may have chemical affinity may be used.

5. If the evolved matters are combustible, they may be burned.

NUISANCES ARISING FROM THE KEEPING OF ANIMALS.

The law clearly recognises the fact that animals may be so kept as to be a nuisance or injurious to health. In the Public Health Act, England, 1875, Section 91, certain statutory nuisances are defined which may be dealt with summarily. Among these occurs the following :—Any animal so kept as to be a nuisance or injurious to health. In the Bombay Act III of 1888, Section 384, sub-section (1), clause (*b*), we find 'no person shall keep any animal on his premises so as to be a nuisance or dangerous to any person'.

Nuisance naturally occurs chiefly where the population is aggregated, and it is more likely to be serious in character where such is dense than where it is sparse, but it is not solely in such circumstances that nuisance may arise; a solitary animal badly kept in or near an isolated house may have an injurious influence on the inhabitants of that house.

The nuisance is at its maximum intensity, perhaps, when in a close passage or blind alley in a densely populated area, several stables badly constructed and cleansed are permitted to be erected. In such places one may notice a persistent ammoniacal odour which may be perceptible at some distance. In Bombay it is a common practice to construct horse stables on the ground floor of dwelling houses. In many instances the syce, his family and relatives live in the stable, constructing a dwelling place either by partitioning off a part of the stable or by constructing a loft on bamboo supports. The great majority of these stables are badly lighted and ventilated.

In regard to cows and buffaloes, a usual practice is to have the animal in one of the dwelling rooms or in the *chowk* or ventilating shaft of the house. Another favourite place is under the stairs.

Now, as in all houses the staircase and central *chowk*, where such exists, form the main channel for the circulation of air inside the house,it is obvious that the rooms abutting on these ventilating shafts must derive their air from vitiated sources, more especially seeing that in practically every instance the cubic and floor area available for each animal is grossly insufficient, the lighting bad and drainage totally absent. Add to this the fact that gross over-crowding of human beings generally exists in the same house and the magnitude of the evil is at once apparent.

In regard to horse stables under dwelling rooms, as usually constructed, whatever effluvia arise from the stable find their way into the residential parts above. Their passage upwards is facilitated in some instances by the staircase leading to the upper rooms being in more or less direct communication with the stable, but even where this is not the case and there is an entrance separate from the stable, the pervading stable odour may still penetrate to the rooms above, either through cracks in the ceiling or imperfections in the brick work or wooden work of the structure itself.

The effluvium nuisances resulting from the keeping of animals proceed mainly from fermenting solid and liquid filth in the stable due to neglect of proper cleansing, from the too protracted use of dirty and sodden litter, from the soaking of urine and excremental matter into the floor as the result of its bad construction or of deficient or inefficient arrangements for drainage. Further, the disturbance of neglected heaps of manure and their cartage through the streets, and the exhalations from the animals' lungs and skin and, in some instances, from diseased surfaces are also sources of possible nuisance. Experiments have been made repeatedly and the results show the necessity for good ventilation in stables, if the air is not to become grossly vitiated and their presence a source of nuisance to the neighbourhood. Obviously, when otherwise, such stables must exercise a most harmful effect on the neighbours and much more so on those people living in the stable itself, not only on account of the direct effects of contaminated air on themselves but also the indirect on their food which is stored and cooked there.

Apart from such stables being a source of nuisance and danger by reason of offensive effluvia, we must remember that one of the principal breeding places of flies is in horse litter, and in a city in which the open basket system of conservancy obtains the risk of Cholera and Typhoid being spread by their agency is by no means negligible. Further, old stables are often riddled beneath by rat runs and, where these communicate with adjoining houses, they not only serve as a channel for the introduction of concentrated effluvium but also of rats and thereby add to the chance of the inmates contracting Plague. In improperly drained stables the possibility of breeding mosquitoes must not be overlooked.

BYE-LAWS RELATING TO HORSE, CATTLE AND MILCH CATTLE STABLES.

Horse and Cattle Stables.

Under clause (*f*) of Section 461 with respect to the control, supervision and prescribing and regulating the construction, dimensions, ventilation, lighting, cleansing, drainage and water-supply of premises used for keeping horses or cattle not being milch cattle—(*a*) for sale, (*b*) for letting out on hire, or (*c*) for any purpose for which any charge is made or any remuneration received.

1. A person or firm having a license from the Commissioner to use any premises for the purpose of keeping horses or cattle (not being milch cattle)—

(*a*) for sale,

(*b*) for letting out on hire, or

(*c*) for any purpose for which any charge is made or any remuneration received,

is in these Bye-laws referred to as "a License-holder," and the premises to which any such license relates are referred to as "licensed premises."

"Stable" means a building used or intended to be used for keeping such horses or cattle upon the licensed premises.

2. A person shall not be entitled to a license to use for keeping such horses or cattle any stable which does not fulfil the conditions prescribed by Bye-law 4. One such license only will be granted in respect of the whole of any

premises, notwithstanding that such premises are so used or intended to be used by more persons than one occupying severally.

3. A license-holder shall not at any time of the day or night—

(*a*) keep on the licensed premises a larger number of horses or cattle than the number allowed by his license;

(*b*) keep in any one stable a larger number of horses or cattle than the stabling capacity of such stable will admit of, according to the standard of floor space prescribed by clause (*e*) of Bye-law 4; or

(*c*) in any case keep in any one stable a larger aggregate number of horses or cattle or of horses and cattle than 100.

4 A license-holder shall not use for keeping horses or cattle on the licensed premises any stable which does not fulfil the following conditions, namely:—

(*a*) the construction of such stable shall, in general principles, conform to an index plan, copies of which are deposited in the offices of the Executive Health Officer, Executive Engineer and Superintendent of Licenses, respectively, where the same can be inspected;

(*b*) its height shall in no part be less than 12 feet measured from the floor to the wall plate;

(*c*) it shall have an open space (open to the sky) of not less than fifteen feet in width all round it within the boundary of the licensed premises, such width to be measured from the outer sides of the external posts;

(*d*) it shall be open on all sides to such surrounding open space, but may be fitted with such screens or weather-boards as the Commissioner may in each case approve;

(*e*) it shall be so constructed as to afford floor space for each horse stabled therein of not less than 12 feet in length by 6 feet in breadth, and for each head of cattle stabled therein of not less than 12 feet in length by 4 feet in breadth, such space to be in each case exclusive of space occupied by any manger, central or side drain;

(*f*) to separate each horse or pair of bullocks to be stabled therein from the next horse or pair of bullocks, there shall be, unless the Commissioner shall expressly give permission to the contrary, a permanently fixed partition, consisting of two bars, one above the other, running lengthwise and fixed at heights of 2 feet and about 3½ to 4 feet respectively;

(*g*) the floor surface of the stable shall be at least one foot higher than the mesne level of the surrounding open space referred to in clause (*c*), and its situation shall be such as to admit of its being properly drained into a drain or place legally set apart for the discharge of drainage.

5. A license-holder shall cause all open spaces around the stables or elsewhere upon the licensed premises to be paved or metalled or tar-macadammed and drained to the satisfaction of the Commissioner.

6. A license-holder and every person using for keeping horses or cattle any portion of the licensed premises, shall, from time to time whenever required by the Commissioner so to do, furnish to the Commissioner a statement in writing containing the correct name of each person who owns any of the horses or cattle for the time being kept upon the licensed premises, and of the number of horses or cattle owned by each such person.

7. A license-holder shall not cause or suffer the dung of any horses or cattle kept on the licensed premises to be deposited in such a situation or in such a manner as to pollute any water supplied for use or used or likely to be used by man for drinking or domestic purposes, or any water used or likely to be used by horses or cattle or other four-footed animals.

8. A license-holder shall cause the floor of every stable to be paved with impervious material approved of by the Commissioner and sloped with a gradient of not less than 1 in 30 to the satisfaction of the Commissioner, so as to prevent any soakage into the ground of urine or other filth.

9. A license-holder shall provide upon or in some convenient place in the immediate neighbourhood of the licensed premises a suitable receptacle or receptacles for dung, manure, soil, filth or other offensive or noxious matter which may from time to time be produced in the keeping of horses or cattle upon the licensed premises. Such receptacle or receptacles may be constructed of masonry, or may be movable on wheels, but in the latter case, shall be lined with metal plates or dammered internally to the satisfaction of the Commissioner. Such receptacle or receptacles shall have an aggregate internal space proportionate to the number of animals kept in the licensed premises and such space shall not be less than 1½ cubic feet for each horse or head of cattle so kept.

He shall cause each such receptacle to be constructed so that the bottom or floor thereof shall be at least 1½ feet higher than the surface of the ground adjoining such receptacle.

He shall also cause each such receptacle to be constructed in such a manner and of such materials and to be maintained at all times in such a condition as to prevent any escape of the contents thereof or any soakage therefrom into the ground or into the wall of any building.

He shall, if so required by the Commissioner, cause each such receptacle to be furnished with a suitable tin, tile or *jowli* roof.

10. A license-holder shall not permit any cart driver or other person to sleep in the stable, nor shall he permit any loft or part of the premises over the stable to be used for purposes of human habitation. Provided that the Commissioner may permit such specified number, as he may think fit, of attendants to sleep on the premises, to prevent accident among the animals; but no attendant shall occupy

any space which will encroach upon the air space prescribed for each animal.

11. A license-holder shall also provide upon or in connection with the licensed premises a paved space to the satisfaction of the Commissioner on which cattle can be washed. Such paved space shall have an area equal to not less than one-twelfth of the floor area of the stable.

He shall also provide a suitable paved or metalled space for the parking of carts or other conveyances in connection with the stable.

12. A license-holder shall also cause every drain or means of drainage upon or in connection with the licensed premises to be maintained at all times in good order and efficient action to the satisfaction of the Commissioner.

13. (*a*) A license-holder shall twice daily, namely before the hour of 9 in the morning and before the hour of 4 in the afternoon, cause the licensed premises to be thoroughly cleansed and flushed and shall daily cause to be removed from the receptacle or receptacles, provided in accordance with the requirements of Bye-law 9, all dung, manure, soil, filth, urine or other offensive or noxious matter produced in or upon the premises and placed or accumulated in such receptacle and shall cause the same to be deposited in such place or places as the Commissioner shall from time to time direct.

(*b*) He shall not cause or suffer a greater quantity of hay, grass or straw to be kept or stored on the licensed premises at any one time than will suffice to meet the requirements of four days of the animals stabled therein.

(*c*) He shall not cause or allow any fire to be lighted in a stable or in any portion of the licensed premises near to any hay, grass or straw stored therein.

(*d*) He shall provide a sufficient supply of water to the licensed premises from a Municipal main and shall not without the previous approval in writing of the Commissioner cause or suffer any water drawn from a well to be used for, or supplied to, the animals stabled in the licensed premises.

14. (1) A license-holder shall, whenever required by the Commissioner, bring out or cause to be brought out from each stable on the licensed premises for the purpose of inspection all or any of the horses or cattle which may for the time being be stabled therein and shall provide every such facility as may be required for enabling the person making such inspection to thoroughly examine the said animals or any of them.

(2) He shall give to the Health Department Inspector of the district immediate notice of any outbreak of infectious disease and shall segregate all sick animals in such place as may be approved by such Inspector pending the orders of the Commissioner or in case there shall be no suitable place on the premises where sick animals can be conveniently segregated, he shall, pending such orders, as aforesaid, remove any such sick animal to some other place approved of by such Inspector.

(3) He shall, immediately on receipt of the Commissioner's orders in regard to the segregation or disposal of such animal, comply with and carry out such orders.

Milch Cattle Stables.

Under clause (*f*) of Section 461 with respect to the control and supervision of premises used for keeping milch cattle for sale or hire or for sale of the produce thereof;

Under clause (*g*) with respect to the inspection of milch cattle, and prescribing and regulating the construction, dimensions, ventilation, lighting, cleansing, drainage and water-supply of dairies and cattle sheds in the occupation of persons following the trade of dairy-men or milk-sellers; and

Under clause (*h*) for securing the cleanliness of milk-stores, milk-shops and milk vessels used by such persons for containing milk.

1. A person or firm having a license from the Commissioner to use any premises for the purpose of keeping milch cattle is in these Bye-laws referred to as "a License-holder," and the premises to which any such license relates are referred to as "licensed premises."

2. "Dairy" means a place in which milk, butter or other products of milk are stored, made or kept for sale or are sold.

3. "Stable" means any building used or intended to be used for keeping milch cattle.

4. A person shall not be entitled to a license to use for keeping milch cattle any stable which does not fulfil the conditions prescribed by Bye-law 6. One such license only will be granted in respect of the whole of any premises, notwithstanding that such premises are so used or intended to be used by more persons than one occupying severally.

5. A license-holder shall not at any time of the day or night—

(*a*) keep on the licensed premises a larger number of milch cattle than the number allowed by his license;

(*b*) keep in any one stable on the licensed premises a larger number of milch cattle than the stabling capacity of such stable or shed will admit of according to the standard of floor space prescribed by Bye-law 6 (*e*);

(*c*) in any case, keep in any one stable or shed erected on the licensed premises after these Bye-laws came into force a larger number of milch cattle than 100.

6. A license-holder shall not use for keeping milch cattle any stable on the licensed premises which does not fulfil the following conditions, namely:—

(*a*) its height shall not be less than twelve feet measured from the floors of stalls to the wall-plate:

(*b*) it shall have an open space of not less than fifteen feet in width all round it, such width to be measured from the outer sides of the external posts;

(*c*) its floor surface shall be at least one foot higher than the mesne level of such surrounding open space, and its situation shall be such as to admit of its being properly drained into a drain or place legally set apart for the discharge of drainage;

(*d*) it shall be open on all sides to such surrounding open space, but may be fitted with such screens or weather-boards as the Commissioner may in each case approve;

(*e*) it shall be so constructed as to afford floor space not less than twelve-and-a-half feet in length by five feet in breadth for each cow or buffalo to be stabled therein, such space to be inclusive of space occupied by any manger, central or side drain, or central passage.

7. A license-holder and every person using for keeping milch cattle any portion of the licensed premises, shall, from time to time, whenever required by the Commissioner so to do, furnish to the Commissioner a statement in writing containing the correct name of each person who owns any of the milch cattle for the time being kept upon the licensed premises, and of the number of milch cattle owned by each such person.

8. A license-holder shall not cause or suffer the dung of any milch cattle kept on the licensed premises to be deposited in such a situation or in such a manner as to pollute any water supplied for use or used or likely to be used by man for drinking or domestic purposes, or any water used or likely to be used by milch cattle or horses or other four-footed animals, or in any dairy, or for cleaning or washing vessels used or intended for milk.

9. A license-holder shall cause the floor of every stable to be paved with impervious material approved by the Commissioner and sloped with a gradient of not less than 1 in 30 to the satisfaction of the Commissioner so as to prevent any soakage into the ground of urine or other filth.

10. A license-holder shall provide upon or in some convenient place in the immediate neighbourhood of the licensed premises a suitable receptacle or receptacles for dung, manure, soil, filth or other offensive or noxious matter which may from time to time be produced in the keeping of milch cattle upon the premises. Such receptacle or receptacles may be constructed of masonry, or may be movable on

wheels, but in the latter case shall be lined with tin plates or dammered internally to the satisfaction of the Commissioner. Such receptacle or receptacles shall have an aggregate internal space proportionate to the number of animals kept in the licensed premises, and such space shall not be less than 1½ cubic feet for each head of cattle so kept.

He shall cause such receptacle or receptacles to be constructed so that the bottom or floor thereof shall be in each case at least 1½ feet higher than the surface of the ground adjoining such receptacle.

He shall also cause such receptacle or receptacles to be constructed in such a manner and of such materials and to be maintained at all times in such a condition as to prevent any escape of the contents thereof or any soakage therefrom into the ground or into the wall of any building.

He shall, if so required by the Commissioner, cause each such receptacle to be furnished with a suitable tin, tile or *jowli* roof. He may provide a loft for storage of hay over any stable on the licensed premises, but not so that any part of any such loft will be less than 12 ft. over the floors of stalls.

He shall not permit any *gowli* or other person to sleep in any stable, nor shall he permit any loft or part of the premises over a stable to be used for purposes of human habitation. Provided that the Commissioner may permit such specified number, as he may think fit, of attendants to sleep on the premises, to prevent accident among the animals, but no attendant shall occupy any space which will encroach upon the air-space prescribed for each animal.

11. A license-holder shall also provide upon or in connection with the licensed premises a paved space to the satisfaction of the Commissioner on which the cattle can be washed. Such paved space shall have an area equal to not less than one-seventh of the floor area of the stable.

12. A license-holder shall also cause every drain or means of drainage upon or in connection with the licensed premises to be maintained at all times in good order and efficient action to the satisfaction of the Commissioner.

13. (*a*) A license-holder shall twice daily, morning and evening, cause the licensed premises to be thoroughly cleansed and flushed and shall cause to be removed from the receptacle or receptacles, provided in accordance with the requirements of Bye-law 9, all dung, manure, soil, filth, urine or other offensive or noxious matter produced in or upon the premises and placed or accumulated in such receptacle and shall cause the same to be deposited in such place or places as the Commissioner shall from time to time direct.

(*b*) He shall not cause or suffer a greater quantity of hay, grass or straw to be kept or stored on the licensed premises at any one time than will suffice to meet the requirements of four days of the animals stabled therein.

He shall not by storing the hay, grass or straw encroach on or diminish in any way the minimum space for animals prescribed by Bye-law 6 (*e*).

He shall not cause or allow any fire to be lighted in a stable or in any portion of the licensed premises near to any hay, grass or straw stored therein.

14. A license-holder shall, whenever required by the Commissioner, bring out or cause to be brought out from each stable on the licensed premises for the purpose of inspection all or any of the milch cattle which may for the time being be stabled therein and shall provide every such facility as may be required for enabling the person making such inspection to thoroughly examine the said animals or any of them.

15. A license-holder, dairy-man or milk-seller shall provide a sufficient supply of water from a Municipal main to the premises licensed to or occupied by them for carrying on his trade, and shall not without the previous approval in writing of the Commissioner cause or suffer any water drawn from a well to be used for, or supplied to, any milch cattle.

16. A license-holder, dairy-man or milk-seller, whose premises do not fulfil the requirements of the next succeeding Bye-law respecting new dairies or stables, shall so far alter the said premises or any part thereof as the Commis-

sioner shall from time to time by notice in writing require for the purpose of bringing the same into conformity, so far as may be deemed necessary, with the said requirements or any of them.

17. A person who shall erect a new dairy or cattle-shed for the stabling of milch cattle belonging to dairy-men or milk-sellers shall construct the same in accordance with the following rules :—

(*a*) The roof shall be tiled or covered with corrugated sheet iron.

(*b*) The floor shall be paved throughout with suitable impervious material approved by the Commissioner and the paving shall be so sloped as to ensure effectual drainage having a gradient of not less than 1 in 30.

(*c*) The stable shall be fitted with mangers, 2½ feet in width, and if the mangers are so arranged that the animals in two rows face each other, a passage of at least 3 feet in width shall be left between the two rows of mangers. The floor of this passage shall be paved in the same manner as the floor of the stable, and the passage shall at all times be kept free of obstruction.

(*d*) The stable shall be drained by an open ovoid drain of such materials and dimensions with such fall and laid in such position and manner in all respects as the Commissioner shall require, and such drain shall be connected with such sewer or other means of drainage as the Commissioner shall direct.

18. A person shall not erect a new stable for milch cattle belonging to dairy-men or milk-sellers within a distance of 15 feet from any street or 25 feet from any dwelling house.

19. A dairy-man or milk-seller shall not sell or keep milk in any dwelling-house or room or place used for sleeping or looking or where other articles of food are kept or where any other trade is carried on.

20. A dairy-man or milk-seller shall cause every part of the internal surface of the walls and ceiling of every room or place in which milk is kept or sold by him to be thoroughly lime-washed twice at least in every year, or oftener if so required by the Commissioner.

He shall also cause the floor of every such room or place to be paved throughout with suitable impervious material approved by the Commissioner and the paving shall be so placed as to ensure effectual drainage having a gradient of not less than 1 in 30.

He shall also cause the floor and drain of every such room or place and every counter, shelf, or bench on which milk-vessels are kept to be washed and thoroughly cleansed daily.

21. A dairy-man or milk-seller shall cause every vessel used in his milk-shop or in the distribution of his milk to be rinsed with boiling water and thoroughly cleansed before and after use.

22. A dairy-man or milk-seller shall not use or permit to be used for the washing and cleansing of milk vessels any water except such as is drawn from a Municipal main or from a well to be previously approved in writing by the Commissioner.

The Keeping of Pigs.

The nuisance which may arise from this cause is so great as to call for special legislation, and one finds that the Public Health Act, England, 1875, section 47, states that pigs must not be kept in towns so as to be a nuisance; and the Public Health Act, London, 1891, section 17, prohibits pigs being kept in the Metropolis, so as to be either a nuisance or within 40 feet of a street. The Bombay Act 3 of 1888, section 384, sub-section (1), clause (*a*), states that no person shall without the written permission of the Commissioner, or otherwise than in conformity with the terms of such permission, keep any swine in any part of the city, and the same section, sub-section (2), says that any swine found straying may be forthwith destroyed and the carcass thereof disposed of as the Commissioner shall direct, and no claim for compensation shall lie for any swine so destroyed.

The offensive odour from ill-constructed and badly kept piggeries is capable of travelling very considerable distances with the wind. The manner of preparation and storage of the food for pig may be a source of nuisance. It is exceptional to feed pigs upon sweet food; they are generally given refuse material of all sorts in which frequently fermentation has already commenced. If, as is sometimes done, this food is boiled, a greater nuisance than ever may arise.

In every case pig styes should be situated at a considerable distance from any dwelling house, and not nearer than 100 feet from any well, spring, or stream of water used or likely to be used by man for drinking purposes or for domestic purposes, or otherwise in such a position as to render any such water liable to pollution.

The stye should have a smooth impervious floor of concrete or of Indian patent stone, properly sloped and provided with channels leading to a trapped drain inlet. If walls are built, they should be of brick or masonry rendered smooth inside in cement or patent stone so as to permit of being readily washed. The stye should be provided with a roof which, if resting directly upon the walls, should have a window in it to provide light and facilitate cleansing.

Under no circumstances must woodwork be permitted in situations in the slightest degree liable to pollution. The stye should be washed regularly once a day at least. If proper attention is paid to construction and the cleanliness of pig styes, there is no reason why pigs cannot be kept without becoming a nuisance. On the other hand, if there is neglect their presence becomes intolerable.

SLAUGHTER-HOUSES.

Slaughter-houses for killing cattle for food have been in existence in India from its earliest days. The ancient Aryans had slaughter-houses where cows and buffaloes and bulls were killed, but no description of the situation and construction of a slaughter-house is available, or of the conditions under which they existed in those primitive times. They were said to be in the open country away from dwelling houses. Centuries have done nothing, however, to improve their conditions and so we find the practice of killing cattle in villages and even in small provincial towns in the open or at best in an open shed. In Presidency and other large towns, Municipalities have provided slaughter-houses, but they are far below the modern standards of public abattoirs in the European continent and British Isles, and they are not laid out and constructed on proper sanitary basis.

The site for the location of a slaughter-yard and house must be carefully selected. It should not be on low lying land, and must be outside the town and in close proximity to running water or the sea and within short distance of a railway line to which it should be connected. The prevailing wind must be duly considered. Further, the locality must be such that the slaughtering of animals should be visible to very few and the noises of cattle audible to a very small circle. All public abattoirs should be under the control of Municipal Corporations; there should be, as far as possible, no private slaughter-houses; all facilities and conveniences should be extended to butchers and cattle dealers; in the event of a butchers' guild or company wishing to establish a slaughter-house, permission may be granted, provided they give the requisite guarantee for the judicious management of the same and are answerable to local authority. The advantages to the public from the provision of slaughter-houses maintained under the control and supervision of Corporations are many. (1) Meat injurious to health is prevented from being offered for sale. All meat unfit for food is destroyed; and meat of doubtful quality, but not unfit, may be offered for sale after "declaration of quality." (2) In properly constructed slaughter-houses, fitted with the newest machines and appliances, slaughtering is conducted with cleanliness and expedition. It is also convenient and cheaper for licensed butchers to kill their animals at such slaughter-houses and it inspires confidence in the public to patronise such butchers. (3) The pollution of earth, water and air, and in India of the meat, caused by careless management in private slaughter-houses is entirely removed. (4) The torture of animals is done away with, as the necessary apparatus and arrangements for the stunning and stupefaction of animals are provided. (5) The animals brought for slaughter are regularly inspected, while those suffering from infectious diseases are killed and their bodies destroyed by incineration. Thus the spread of infectious disease among animals is efficiently prevented. The condemned meat is also destroyed. In connection with slaughter-houses there should be a spacious cattle yard, where animals may be purchased by butchers from cattle dealers. The yard should, if possible, be covered over with turf and provision made for the conservancy of the same and daily removal of all refuse and dung. Lairage accommodation in properly constructed sheds should be provided where animals may have rest before slaughter, as only after sufficient rest of the body they furnish sound and normal meat; it is well known that fatigue impoverishes the meat. The lairage stalls or pens should not be too large, so that in case of infectious disease the infection may be limited and disinfection rendered more easy. It is, therefore, necessary that the floors of the lairage stalls should be properly paved and made water-tight and drained. The walls, too, should be rendered smooth and non-absorbent, impervious to a sufficient height above the size of the animals, and the corners rounded off. No doubtful animal or with any suspicion of infectious disease should be allowed into the cattle yard or the lairs. Sufficiently large and commodious inspection-sheds should be provided. They may be open on all sides, but should be properly paved and drained.

In connection with the inspection-shed there should be a properly equipped laboratory. The cattle yard, inspection-sheds, lairage-sheds and awaiting-pens should be entirely divided off by a high masonry wall from the slaughter-house proper so that the animals awaiting slaughter may not witness the slaughtering of their comrades. In many slaughter-houses, the awaiting-pens are mere annexes, whence the animals witness the slaughtering and, even on account of faulty drainage arrangements, blood of the slaughtered flows to their very noses. The animals awaiting slaughter should be spared, as far as possible, any contact with sights or smells of the slaughter-house itself.

There is another economic value in entirely keeping apart animals awaiting slaughter, as it appears to be a well established fact that the flesh of an animal killed in a state of fear or excitement loses some of its palatable and marketable qualities; above all, humanity demands that they should be spared the painful sights and cries. The common practice of depositing blood barrels, freshly removed hides or offal and refuse from slaughter-houses in close proximity to waiting pens should be strictly prohibited.

In designing a slaughter or killing-house several points have to be duly considered. It should be sufficiently large and commodious to meet the special demands of the town population, whose meat it intends to supply. Slaughter-houses are built in different countries either under the separate or block system, the former also called French and the latter German.

The first (French) is built on the principle of providing each butcher with a room for himself in which to kill. These rooms lie on each side of a central passage which has a door at each end. Every small room has a door into this passage and another leading directly outside the abattoir. The characteristic of the French system is that each building is isolated and surrounded by an open space. In the larger towns where butchers are divided into butchers proper and salesmen, this system works very well; it is the more expensive of the two. In the block system (German) all the buildings of a slaughter-house are under one roof or, if a little away from it, connected with it by covered passages. The block system is not suitable to India, as there will be no free air-space around the building. The separate system is the best adapted for this country. The buildings in the slaughter-yard must be arranged so as not merely to be suitable for the actual number of inhabitants in the town, but also with a view to their increase, so that extensions can easily be made. The slaughter-yard must therefore be extensive. The following principles were given for the erection of the public slaughter-house of Bromberg. The area of ground must be at least 6½ sq. ft. per inhabitant in towns of 3,000 inhabitants; 5½ sq. ft. per inhabitant for towns of from 3,000 to 5,000 inhabitants; 4½ sq. ft. per inhabitant for towns of from 5,000 to 7,000; 4 sq. ft. per inhabitant for towns of 7,000 and more. For 7,000 to 10,000, 3½ sq. ft.; 10,000 to 50,000, 3 sq. ft.; over this figure 2½ sq. ft.

The abbatoir or killing-house should be of solid substantial material and should be up-to-date. The material used for the building, walls and floors must be durable and impervious and non-absorbent. The internal surface of the walls, to a height of at least 10 feet, with corners rounded off, must be rendered smooth and water-tight, so that the internal surface may be daily washed down with a hose. It is best to paint the inner surface with white oil-paint, as the same would show off dirt and will help to a considerable degree to reflect better light; if expense is not of much consideration, the internal surface of the wall may be fitted up with white, glazed tiles or even marble slabs. The floors of the slaughter-house and room for cleaning utensils, etc., must be firm, hard and tough and water-tight and must be sloped all round, having a drain at the lowest point discharging into a gully and trap to prevent gases from drains escaping and penetrating into the slaughter-house. The floors must be such as to resist being broken or cracked by the falling of heavy objects or with the stamping of animals. They should not be smooth and slippery. They may be rendered on the herring fish-bone pattern so that they can be easily washed and cleansed. The corners in walls and floors must be rounded off to prevent the collection of dirt and dust. The slaughter-house should be properly ventilated and lighted by doors, windows and sky-lights. The doors and windows should be provided, in addition to the ordinary shutters, with "fly-proof shutters" and they must be so fixed as to work automatically unless otherwise prevented. The sills of windows must be at least 5 ft. 9 inches above the floor. The doors and windows must be so arranged that the public cannot see in the slaughter-house. In connection with the slaughter-yard, a provision should be made also for a manure-house, offal-house, water-closets, disinfecting accommodation, boiler house, a cold room, a cooling room, lavatories for butchers and their assistants, and, if possible, an incinerator and refrigerator and sterilizer. Besides these, there should be offices and dwellings for officials and the inspecting staff. The slaughter-yard and house should be provided with a plentiful good water supply. The drainage should be on the most modern lines and the sewage treated biologically before being discharged into the sea, river or on the land. The blood which flows out at killing must be caught in vessels kept in the slaughter-house for that purpose, so that the floor may be soiled as little as possible and not rendered slippery.

Blood when required for preparation of sausages must be collected in thoroughly clean and air-tight receptacles. All blood not so used should be boiled down in the shed provided for the same and used as manure.

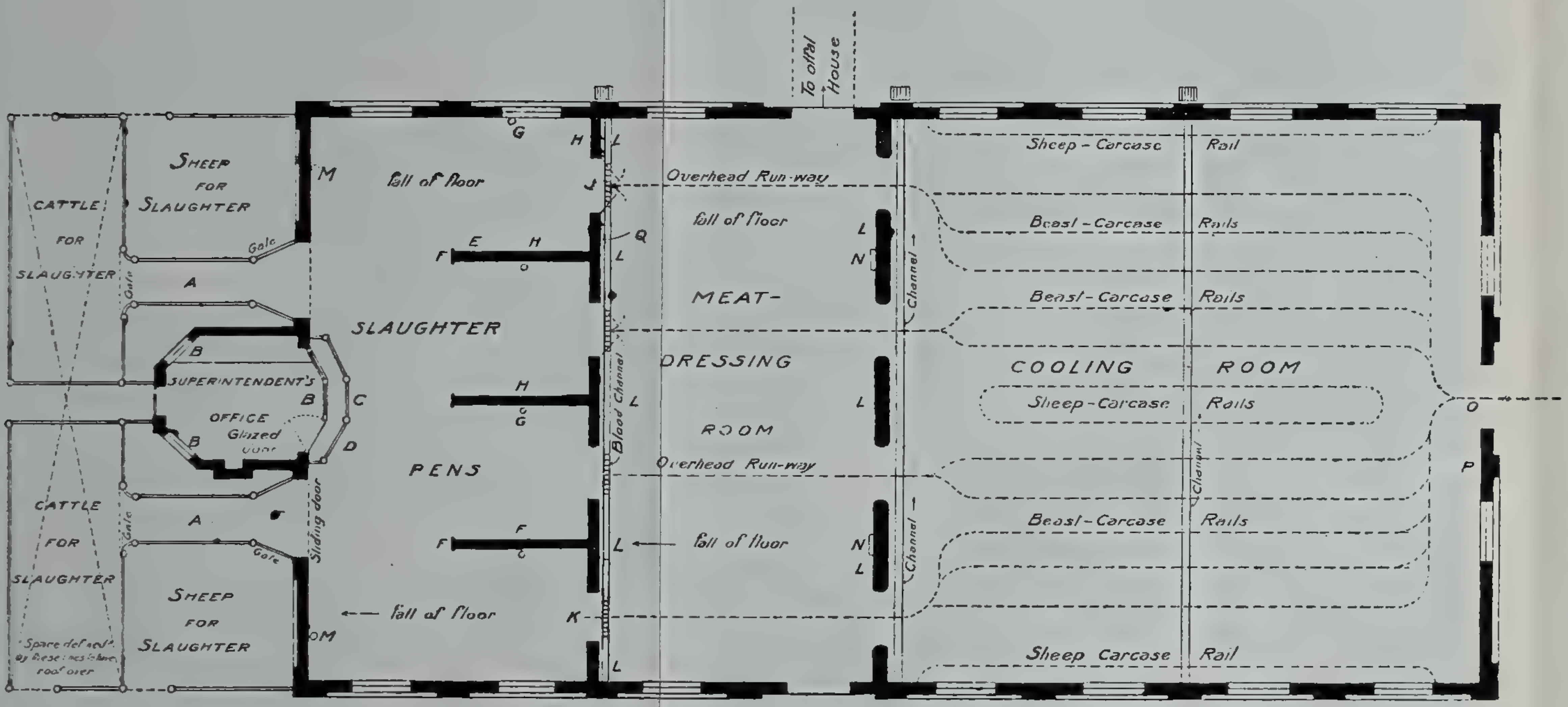
All entrails must be cleaned in the offal-house. The walls of this house should be very clean, made of marble or glazed brick or tile. The floor also should be of good gradient and made of the same material. The house should have a plentiful supply of water and the offal refuse removed daily as soon as the slaughter-house is cleaned. The offal-house must be daily washed down. Expert advice should be obtained for the provision of machinery, hoists, cranes stunning machines and other appliances needed for the slaughter-house. They should be of the latest pattern.

In India the practice of slaughtering is ritualistic ; it is not unlike the practice which obtains among the Jews all over the world. The bulk of the meat-eating population is Mahomedan and in almost all places the butchers are of that religion. According to their ritual, the process of slaughtering serves to render the slaughtered animal *halal*, *i.e.*, partly a sacrifice and partly a ritualistic offering.

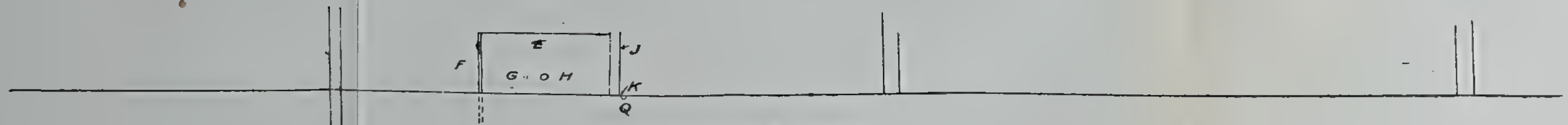
PLAN.

H. M. DOCKYARD, CHATHAM.

NEW SLAUGHTER HOUSE.



PLAN



SECTION SHEWING FLOORS

REFERENCE.

A.A.	Passage way from Cattle Pen to the Slaughter Chamber.
B.B.	Windows overlooking Waiting Pens and Slaughter Chamber.
C.	Iron guard rail to keep Cattle away from windows of Superintendent's Office.
D.	Bar hinged for access to Office.
E.E.	Brick divisions 5'-0'' high by 11'-0'' long between Slaughter Pens.
F.F.	Iron channel-shaped posts with edges rounded and ends bedded firmly in concrete.
G.G.	Slaughtering-ring in wall 2'-0'' above Floor.
H.H.	Tube through wall for rope used to haul wild or dangerous cattle up to Slaughtering Ring.
J.J.	Self-Closing screen-doors 5'-6'' high from floor with bottom 18'' cut off.
K.K.	1⅛'' dia. bars 4½'' apart over gutter flush with Floor as grating.
L.L.	Offal-hooks on walls.
M.M.	Hoses for flushing.
N.N.	Winches for hoisting Carcasses and for hauling dead Cattle from Slaughter Pens into Dressing Room.
O.	Weighing-Machine for Sides.
P.	Do. for Joints.
Q.	Blood-Channel having a sharp fall to ensure all fluid being carried off.

NOTE.—Walls finished in glazed brick up to 5'-0'' from ground.

The animal is not stunned but bound and knocked over and the butcher cuts the neck transversely just below the lower jaw, giving a clean sweep from ear to ear, cutting all the chief arteries and veins of the neck right down to the spinal column. There is no question as to the cruelty meted out to the dumb animal as this could be obviated by rendering the animal unconscious by a stupefying blow, as some three or four minutes must elapse before the cutting process is begun and more before it is completed. The animal will thus be saved the lengthened period of unnecessary torment, without regarding the injuries and wounds of all sorts caused by the " throw " or death struggles. Humanity demands that this should be so. One often has seen Mahomedan *shikarees* making the *halal* after an animal or wildfowl is knocked down and rendered unconscious by a gun-shot. The Jewish method of killing does not rest on any command of God, that is to say, has no Biblical foundation but is authorised as a command of the Talmud by a number of learned Rabbis. If this matter is properly explained to the butchers and others, there is no doubt the demand of humanity will prevail and animals will be spared the cruel process now in force.

In India fresh pork meat is a luxury occasionally indulged in by Christians and a few of the Chinese. There are no public slaughter-houses for pigs but only private under the Corporation surveillance and license. Only 2 or 3 pigs are slaughtered a day. The scalding and the scraping of hair is done in the room where the animal is slaughtered. The animal is not stunned before killing. It is not understood why this should not be in the case of pigs, as the butchers are all Christians, and consumers would rather prefer the animals rendered unconscious before they are slaughtered.

The plan attached is of a model slaughter-house built in H. M. Dockyard, Chatham.

GLUE MAKING.

Glue is obtained by boiling bones, hoofs, horns, scraps of skin, leather and waste animal matter in general. The materials are first limed and then washed in water to remove the lime. They are then boiled, the fat which rises to the surface being skimmed off, and the liquid glue underneath is run off into shallow moulds and allowed to solidify.

The accumulation of materials of the trade may cause some nuisance; this can be lessened by liming the layers of materials in the stacks and by taking particular care to see that they are kept dry.

The effluvium given off during the boiling process should be burned or condensed in water and in either case finally discharged *viá* a high chimney. The scutch or debris which is left in the vat after the glue has been run off should be removed from the premises as soon as possible; otherwise much nuisance must arise.

GUT SCRAPING.

The small intestines of pigs and sheep are cleansed and then soaked in water for a few days to soften. They are then scraped on a bench until practically nothing but the peritoneal covering is left. They are then placed in water again.

The subsequent treatment varies according to whether it is desired to make sausage skins or catgut. If the former, the guts are simply placed in salt solution ; if, however, catgut is desired, they are treated with sodium carbonate and are then spun and finally bleached with sulphur fumes and dried. The trade, if improperly carried out, is a most offensive one, but it need not necessarily be so. The premises should be well constructed, lighted and ventilated. As large amounts of water are used, the floor should be of concrete properly sloped and drained. The walls for a height of at least six feet must be rendered in some smooth impermeable material, *e. g.*, concrete or Indian patent stone. The tables on which the guts are scraped must not be of wood but be made of stone. The guts should be stored in impermeable receptacles ; wooden tubs should not be used. The waste liquids before being passed into the drains should be deodorised by chlorine water. It is of the utmost importance that a high degree of cleanliness be maintained, as, if this be the case, no nuisance should arise. For other precautions against nuisance, reference can be made to the introductory remarks on this section.

FAT MELTING.

The chief substances used are beef, mutton and pig fat, kitchen waste, waste meat and the materials obtained from boiling bones and scraps at knackeries and glue works. The degree of nuisance caused by fat melting depends largely on the freshness or otherwise of the fats, and on the means employed for melting. There are three methods which can be employed, *viz.*, open fires, free steam either with or without the use of sulphuric acid, and lastly steam jacketed pans.

The fresher the fats are the less the nuisance. Unquestionably the most objectionable method of melting is that where an open fire is used, and generally speaking the higher the temperature the greater the degree of nuisance. If done over open fires, the melting should be carried out at the lowest temperature possible, and suitable appliances should be used for conducting away the fumes generated. By far the best method is to use steam, either free steam or steam jacketed pans. The advantages are obvious: the fat is not in direct contact with the fire, thereby lessening greatly the risk of nuisance; the fumes are collected and burned and, finally, the fat is easily run off into suitable receptacles in a simple and cleanly manner, so avoiding a frequent cause of complaint, *viz.*, the fouling of the surroundings which occurs in the process of removing the melted fat from the pans to the cooling receptacles. Under no circumstances should an establishment for the melting of fat be permitted to be erected in a populous neighbourhood, unless it is worked by steam. The other requirements of a fat melting works have already been detailed in the introductory remarks. Particular attention should be paid to the provision made for the storage of fat prior to melting. Covered metal receptacles should be insisted upon in every instance, as otherwise much nuisance may arise

FELLMONGERING.

A fellmonger is one who receives the skins of sheep and prepares them for the leather dresser. Two classes of skins are received, *viz.*, fresh, and dry imported foreign skins. The fresh ones are first of all cleansed from dirt by being beaten by a mallet and then soaked in water, after which they are limed either by placing them in a pit containing milk of lime or, as is more usual now, by applying cream of lime to the fleshy surface by a brush, the skins being afterwards folded with the fleshy surface inwards. They are now hung up to allow the wool to become loose and when this occurs they go to the pulling house, where the wool is removed. They are now known as pelts, and are thrown into a pit containing milk of lime until they go to the leather dresser.

The foreign skins being dry and hard are softened by placing them in water for some hours. While damp the skins are now hung up in a fairly warm chamber, where a slight superficial putrefaction takes place, enabling the wool to be readily pulled off. The skins are not limed. The subsequent treatment resembles that for fresh skins.

LEATHER DRESSING.

A leather dresser is one who receives pelts as well as horse, seal, calf and goats' skins. All these latter he treats as regards liming and scraping, etc., just as described under fellmongering.

Having received the pelts, etc., he subjects them to a process known as breaking, which consists in scraping the fleshy side, with a curved knife so as to remove the connective tissue, &c. The parts removed are known as fleshings. The skins now go back into pits of lime of varying strength for varying periods. The next process is to wash out the lime, after which the skins are placed in a solution of puer, which consists of dogs' dung. In this they remain for a period varying according to strength. They are now scraped and washed and pass to a mixture of bran and water known as drench. In some works no puer is used, the skins going direct into the drench.

The pelts are now ready for either tawing or tanning.

For tawing the prepared pelts are placed in a barrel containing salt, alum, yolk of egg and water.

TANNING.

A tanner is one who receives raw bullock-hides and prepares and tans them. Occasionally, all the three trades are carried out in the same premises. The tanner receives three classes of hides, *viz.*, fresh, salted and dried.

Treatment of fresh hides.—The first process is liming in a series of pits of varying strength . To secure even action the skins are drawn out daily and replaced. The hair is next removed. The hides are then washed in clear water and then the fleshings removed with a curved knife. Of the strictly tanning process, the first part is called colouring : the skins suspended on poles are lowered several times daily into a pit containing old tan liquor. The object is to colour all the parts evenly. They now go to the tan pits, passing through pits of gradually increasing strength. The materials used are oak, mimosa, valonia, hemlock and chestnut. Salted hides are treated in the same way, except that they are first soaked for a day or two to get rid of the salt Dried hides are placed in water and afterwards beaten until they are soft. Both then undergo the same treatment as fresh hides.

The following is a short account of the processes carried out in the Bombay Tanneries :—

The skins are washed in three or four changes of fresh water. They are then immersed in lime solution for 8 to 10 days, during which time they are turned each day so as to secure even action. The hides are now removed, washed and scraped with the curved knife already referred to. They are again washed and placed in another solution of lime for 3 to 4 days, removed, washed and again scraped. They are now washed and trampled under foot in order to render them pliable. The hides are now immersed in a bark solution for 10 to 12 days, the hides being turned daily. On removal they are again dressed with the knife. They are now put in a second bark bath for a similar length of time and on removal dressed as before. They are now placed in the myrabollan bath for 3 days. On removal they are dried and, when all moisture has been extracted, they are oiled and hung up ; when dry they are rendered pliable by being beaten on large smooth stones, after which they are packed in bales ready for transport. The above is the method adopted for sheep and goat skins ; for cow hides and other large skins, there is an additional third bark bath. The whole process takes 40 to 50 days and for large skins 60 to 70.

Sources of Nuisance in the foregoing Trades.

1. In the reception of the raw skins and imperfectly cured foreign hides and their transference from one place to another.

2. The ammoniacal odour proceeding from a large number of skins painted with lime.

3. The emptying and cleansing of the tanks where the skins are washed.

4. The removal of waste lime from exhausted lime-pits.

5. The process of puering and the discharge of waste puer and drenches, etc., into drains if untrapped or into open drains and streams.

6. The drawing of skins from lime-pits.

In Bombay the chief nuisance appears to be due to lack of supervision and to the hopeless overcrowding of lime and tan tubs on the premises, as a result of which it is almost impossible to properly cleanse the premises.

The premises in which these trades are carried on must be well constructed. The floors should be of concrete, sloped and drained. The walls should be coated with cement to a height of about 8 feet. The pits must be made of a material which will not readily flake or wear away and the corners should be rounded off so as to facilitate cleansing. The entire processes should be carried out in closed buildings lighted from the roof and well ventilated.

The water in the tanks where skins are cleansed should be changed daily. Waste lime and fleshings should be removed daily. Puering can be carried out using a cold solution, although this method takes longer, and in any case it must be done in a closed chamber ventilated by a special shaft discharging well above the roof of the premises. In some works the waste puer and drenches are collected in a tank and allowed to settle and treated with lime before discharge into the drains. All waste tan material must be removed daily, and it should on no account be burned on the premises as this may cause great nuisance. The interior of the tannery, etc., should be lime-washed at frequent intervals. All tan tubs should be laid in regular parallel rows with a space of at least 2½ feet between each row to permit of proper daily cleansing ; since this has been insisted upon in the local tanneries much improvement has resulted.

Apart from nuisances there are certain definite dangers in connection with these trades, *viz.*, Anthrax, lead poisoning, arsenical poisoning and mercurial.

Lead poisoning may arise from the fact that oxide and other salts of lead are used in the preparation of certain forms of leather. Arsenical poisoning may arise owing to arsenical salts being used to preserve the skins during transit or to their use in the treatment of certain varieties of skins. Mercurial poisoning may arise from the same cause.

Skins treated with a mixture of lime and orpiment may on washing cause the water to give off sulphuretted hydrogen gas leading to the formation of arsenious acid and sulphurous acid.

Anthrax may arise from handling infected hides from Russia, Persia, Turkey and India. The infection may result from inoculation through the skin *via* a wound, or from inhalation or from swallowing the bacillus.

Much attention has been paid to this subject and Seymour Jones has brought out a process for dealing with hides to lessen the risk of this disease. A disinfectant to deal with hides must be capable of destroying the spores of Bac. anthracis when present on hides and skins under any of the conditions in which they may be supposed to occur naturally, *e.g.*, when protected by hard dried blood. It must not injure the hide nor interfere with any of the subsequent processes by which they are converted into leather. It must be simple, cheap, and non-dangerous or non-poisonous to those who have to carry out the disinfection.

His process consists in placing the dry hides for 24 hours in a soak which is made up to contain 1—2 per cent. of formic acid and ·02 per cent. of perchloride of mercury and then salting them with sodium chloride. The action of the soak is to swell up the fibres of the hide by causing them to absorb water, the result being that the hide returns to a condition closely resembling that in which it was when taken from the animal carcass. This swelling action also affects the dry albuminous matter which may be supposed to protect the spores and permits of the action of the perchloride of mercury. After the soak the salt, by again abstracting water, converts the hides into a condition which differs very little from the wet salted state of a hide, which had been so treated immediately after flaying. It is claimed for this process that no damage is done to the goods, that the process is simple and can easily be carried out at the port of shipment by unskilled labour, that it is cheap and that there is no danger in using perchloride in the required dilutions, the goods requiring very little handling.

Storage and pressing of hides.—Fresh skins after being beaten, soaked and washed are salted, and sometimes treated with a mixture of lime and orpiment and then dried. In the subsequent handling of these skins, either loose or in bales, there is a considerable amount of disagreeable smell and dust evolved. This dust has been shown to contain arsenic. For these two reasons it is not desirable to have hide depôts located in or near thickly populated parts of a city.

FERRO-SILICON : ITS USES AND DANGERS.

Ferro-silicon is an alloy of iron and silicon used in the manufacture of steel. Its transport has occasioned many deaths. As its use is spreading and as steel and iron works are springing up in India, these few notes as to its dangers are inserted. It forms an essential ingredient as regards its silicon in the manufacture of certain grades of steel, to which it is added in small quantities while the metal is in a molten condition. Silicon has a high calorific value and acts as a metallurgical fuel; hence by causing molten steel to remain fluid for a long time, it enables thin and intricate castings to be made and by reducing action it prevents the formation of blow holes in castings. The addition of silicon to steel imparts to it, among other valuable physical properties, a high tensile strength when present to the extent of rather less than 1 per cent. together with small quantities of carbon and manganese. The low grade variety, containing not more than 15 per cent. of silicon, is made in blast furnaces to a considerable extent, while the higher grades are made in the electric furnace.

Dangers in connection with transport and storage.—High grade ferro-silicon is liable to evolve gases of a deadly nature when brought into contact with water, or even when exposed to the action of moist air. This dangerous tendency is more especially referable to certain grades of it, especially those averaging a content of between 40 and 60 per cent. silicon, and some of these grades show the curious physical property of spontaneous disintegration, the lumps of which they consist being found to be liable to crumble during transport and in some instances to actually fall to powder, thus presenting a large surface to the action of a moist atmosphere with consequent greater evolution of poisonous gases. A careful examination of a large number of samples has shown that this tendency is confined more especially to the middle grades.

Manufacture.—A mixture of steel turnings with quartz and coal is put in an electric furnace and heated.

Impurities.—Certain impurities originally present in the coal, iron and quartz used, or formed from them during the process of manufacture, are always present, and some of these are the ultimate cause of the accidents which have occurred. Calcium phosphate $Ca_3(PO_4)_2$ one of the impurities present in coal and in quartz, in itself harmless and widely diffused in nature is responsible for the production of calcium phosphide, which remains in the ferro-silicon and in contact with water or moist air is decomposed with the evolution of phosphate of hydrogen (PH_3). Arsenic is another impurity liable to be present in various combinations in coal and in iron, and this is present in ferro-silicon apparently as calcium arsenide which is also decomposed by water or moist air, evolving arseniuretted hydrogen, a gas scarcely, if at all, less poisonous than PH_3.

Acetylene was formerly found as an impurity, but this was probably due to the fact that the furnaces used for the manufacture of ferro-silicon were also used for making calcium carbide. Siliciuretted hydrogen has also been suggested as an impurity liable to cause poisoning ; but on contact with moist air this gas splits up into silica and hydrogen.

The poisonous emanations from ferro-silicon on contact with water consist mainly of phosphoretted hydrogen, sometimes alone but for the most part accompanied by varying proportions of AsH_3. These two gases are deadly poisons, and among the symptoms, common to both, produced by their inhalation are severe abdominal pains, nausea, vomiting, great weakness and prostration, gradual loss of consciousness and death frequently within 24 hours. Among other signs, etc., are cold, clammy sweat, pulse almost imperceptible, breathing slow and light, crepitations over the chest, and pupils somewhat dilated. Phosphoretted hydrogen has been proved by recent experiments to be fatal to animals when present in the air in the small proportion of 0·025 per cent., and so far as experience goes AsH_3 is scarcely less poisonous.

The various grades have been classified into three groups:—

Class 1:—10 to 30 per cent. silicon, containing practically no poisonous impurities and not liable to spontaneous disintegration.

Class 2:—70 to 90 per cent. of silicon, not entirely free from poisonous impurities but not liable to disintegrate.

Class 3:—35 to 60 per cent. silicon, containing in most instances a considerable proportion of poisonous properties and in addition being more or less liable to disintegration.

The volume of gas given off varies and Hake found that certain low grades yield on an average 0·2 cubic feet per ton, while certain high grades yield 2·1 to 5·7 cubic feet, and the intermediate grades containing from 42 to 52 per cent. of silicon yield the largest amount, *viz.*, 2·1 to 16·8.

It will thus be seen that the atmosphere of a cabin on board ship might under certain circumstances very rapidly assume a toxic character, if ferro-silicon forms a part of the cargo. One of the conclusions arrived at by D. Copeman is that low grade ferro-silicon (10 to 15 per cent.) does not evolve poisonous gases even in the presence of moisture. Ferro-silicon of all grades up to and including 30 per cent. appear to be practically innocuous and this applies probably to those above 70 per cent. though in a considerably less degree. The proprietors of iron and steel works are therefore advised to restrict their orders to grades of this material either not exceeding 30 per cent. or 70 per cent. and upwards, according to the special nature of their requirements. Copeman and Hake are therefore in accord in their experiments and findings.

Regulations recommended.

1. Ferro-silicon should not be sent out of the works immediately after manufacture, but, after being broken up into pieces of the size in which it is usually sold, should be stored under cover, but exposed to the air as completely as possible for at least a month before being despatched from the works.

2. Manufacturers should be required to mark in bold letters each barrel or other parcel of ferro-silicon with the name and percentage grade of the material, the name of the works, the date of manufacture and the date of despatch.

3. Its carriage on passenger vessels should be prohibited. When carried on cargo boats, it should, if circumstances permit, be stored on deck. If considered necessary to store it elsewhere, the place of storage must be well-ventilated and be cut off by air-tight bulkheads from the quarters

occupied by the crew. This is to apply to river and canal boats. Storage places at docks, or at works where ferro-silicon is used, must be well ventilated and away from work rooms, mess rooms and offices. References : *Lancet*, January and July 1910, and " Ferro-silicon, with special reference to the poisonous gases evolved therefrom," H. Wilson-Hake.

Danger in the manufacture of Patent Fuel with pitch (Briquettes).

The trade is chiefly carried on in South Wales. The process consists as under :—Pitch is broken up and mixed with small coal in a proportion varying from 8 to 10 per cent. of the mix ture. This mixture is first reduced to dust in machines, then treated sufficiently to melt the pitch and finally pressed into moulds to form briquettes.

The danger to health arises from the action of flying fragments of pitch and pitch-dust on the eyes and of pitch-dust on the skin.

Fragments of pitch rise during the breaking or digging of the pitch ; they may cause wounds which are difficult to heal and may eventually lead to impairment of sight or even blindness. The pitch-dust causes chronic changes in the corneal and selerotic coats of the eyes, while upon the skin it causes dermitites and warts. These latter, while primarily non-malignant in character may, when they occur in particular parts of the body, *e.g.*, the lips or genital organs, more especially the scrotum, become epitheliomatous in character. A similar disease is seen in chimney sweeps. The actual ingredient of the pitch which causes the warts has not yet been determined. They form on the body after a considerable period of working in the briquette factory.

Draft regulations have been drawn up and include proposals for—

(*a*) The prevention of dust in the factories by encasing the elevators and disintegrating machinery.

(*b*) The wearing of over-alls by the workmen, and the removal of dust from the skin by bathing and washing at the works.

(*c*) The wearing of goggles to protect the eyes to be made compulsory.

(*d*) Powdering of the skin with Fuller's earth or smearing the body with vaseline before commencing work has been recommended.

Experiments are being made in order to determine what is the actual harmful substance in the pitch and also what are the best means for removing pitch from the skin. *Lancet,* September 30th, 1911.

SUGAR REFINING AND SUGAR REFINERIES.

Sugar is largely adulterated by mixing it with inferior or impure kinds of sugar. Impure sugars are dark in colour, imperfectly crystallized, heavy and clammy, and readily cake into masses. They are found to contain fragments of cane, and woody fibre grit. Sugar is also adulterated with starch with a view to improve its colour, and with water of the treacle or molasses. Hence there is a large business carried on in India which is known as 'refining sugar,' and the manufacture of sugar-candy or *khuri sukkur* and finely powdered sugar or *pithi sukkur.*

The process of sugar refining in India differs from the methods employed in Europe. The modern methods of refining as carried out in Europe are to dissolve the raw sugar, treat it with lime, and then clarify and filter it. It is then decolorized by mixing it with animal charcoal or bone-black and filtered again. The result is a clear, transparent, slightly yellow fluid to which a trace of ultramarine blue is added. It is now transferred to a vaccum-pan and evaporated until it is of sufficient density to crystallize, and then centrifugalized.

The sugars used for refining in India are: (*a*) Mauritius No. I; (*b*) Java No. I; and (*c*) the English beet-sugar.

The basis of the process in India is to treat the syrup with milk and water in the proportion of five parts of milk to one part of water, with a view to removing the impurities. The sugar is dissolved in hot water in a large vat placed over a furnace and heated to the boiling point, the mixture being constantly stirred so as to prevent the sugar from being charred. The proportion of water used is about five gallons for every bag of sugar weighing six maunds. When the mixture of sugar and water attains the boiling point, milk mixed with water in the proportion of five parts to one, is gradually put into the boiling syrup. The effect of this is to cause a scum to appear on the surface together with particles of dirt. Cold water is then added from time to time so as not to overboil the syrup until all the dirt rises to the surface.

The next procedure is to remove the scum by means of flat, perforated iron spoons and set it aside for further treatment. The clear syrup is next stored in large galvanized zinc or copper tubs fitted with stop-cocks. When sufficient syrup is collected, the cold syrup is drained off through the taps into flat-bottomed pans, and placed over a small fire-place and allowed to boil until it attains a certain amount of consistency. This is next poured into a flat iron tray and kept to cool for a period of seven days when it solidifies in layers. The solidification is complete at the bottom, above this is a layer of treacle or molasses, and the topmost layer consists of crystallized sugar.

At the end of seven days, a hole is pierced into the upper or crystallized layer, and the trays are kept in a slanting position over a sloped staging of galvanized iron so as to drain off the treacle or molasses. This treacle flows into a tray and is kept for further treatment. When all the treacle has been drained off, the trays are removed and the crystals of sugar collected over a mat, while the solidified layer at the bottom is broken up into small pieces. The sugar-candy is then sieved so as to remove the finer particles and sorted into four sizes. The sugar-candy thus produced is of a white colour.

The treacle which is drained off the trays is further boiled in flat-bottomed pans over an open fire-place, and constantly stirred until it attains a consistency, when it is put into pans and allowed to cool for some days. It then solidifies into three layers in the same way as described above, and when cooled, the same process of piercing a hole into the upper crystallized layer and draining off the treacle into pans is repeated. In this second process, as the treacle is further heated, a certain amount of browning of sugar takes place, and hence the sugar-candy is of a brown colour somewhat resembling toffee.

The treacle that remains from this second boiling is further heated in an iron pan over an open fire-place until it attains a certain amount of consistency, when it is poured into buckets and formed into a substance called "*goor*."

The scum or dirt, which is removed and set aside in the first part of the process of refining sugar, is then mixed with water in varying proportions and boiled to the boiling point. It is then sieved in a basket covered with cloth and the liquor is used to make *goor*, in the manner described above.

The liquor or uncrystallizable solution of sugar and the scum or dirt is also sold to native tobacconists to make *guracco*, *i.e.*, tobacco sweetened with molasses.

Pithi sukkur is made in the same way as sugar-candy, except that, instead of allowing the thick syrup to solidify or crystallize, it is removed from the pan and macerated by a wooden spoon until the syrup is triturated into a mass resembling flour.

This trade is an offensive one, and it should therefore not be permitted in crowded areas. The sources of nuisance are the following :—

(*a*) In the process of boiling the sugar, very offensive odours are given off which pervade the neighbourhood for some distance.

(*b*) The smoke, if there is no proper flue and chimney, is allowed to escape through windows or doors or gratings in the roof, and thus causes nuisance to the neighbouring residents.

(*c*) Flies are attracted in large numbers owing to the storage of sugar on the premises.

It is necessary in the public interest that this trade should be carried on under wholesome conditions, and for that purpose the following requirements should be demanded :—

(1) The building in which this trade is carried on should preferably be a ground-floor structure. It should be well ventilated and should not be used for residential purposes.

(2) The floor should be paved with smooth stone or tiles, so as to be readily cleaned and washed.

(3) There must be a proper flue and chimney to conduct the smoke and fumes from all the furnaces. The chimney should be carried above the eaves of neighbouring buildings. For this purpose it is recommended to build furnaces with chimneys on the lines of the kitchen "copper" used in England.

(4) The fuel used in the furnaces should preferably be coke, instead of firewood or coal.

SILVER SMELTING, CASTING METALS, ETC.

These trades as carried on in India may be classified as under :—

(1) Casting of the metals, iron, lead and copper and the casting of brass. This latter consists of an alloy of copper and zinc in the proportion of 2 of copper to 1 of zinc. It is harder than copper and can be more easily worked and for most purposes its quality is considerably improved by the addition of 1 to 2 per cent. of lead.

(2) Melting and refining of silver.

(3) Extraction of silver and gold from embroidery.

(4) Silver wire-drawing.

(5) Working in gold and silver for ornaments and jewellery.

(6) Working in copper, brass, tin, aluminium for the making of household utensils, etc.

Each of these trades will now be described in detail.

I.—Casting of the Heavy Metals, Iron, Lead, Copper and Casting of Brass.

It appears that in large works, with few exceptions, furnaces protected by a hood and provided with a chimney are used. The fuel employed consists of coal and coke.

In some of the places, in addition to the casting of metals, a workshop is provided which results in further vitiation of the air by the addition of minute particles of metal. The majority of these works are carried on on the ground-floor of houses used for human habitation, in rooms where the means of ventilation are very defective, and where the cubic air space available is not sufficient to dilute the products of ordinary combustion, the amount of which depends upon the degree of perfection of combustion. In smaller works specially constructed shallow furnaces are used, the fuel being the same as in larger works.

It must be understood that in none of these works is smelting, in its ordinary sense, carried on. The metals are simply melted and cast for purposes of commerce and no ores are treated.

II.—Melting of Silver.

Old jewellery, silver coins, etc., are melted in furnaces in which a very high temperature is reached. Where large quantities are dealt with, iron hoods and a chimney are provided to carry off the gases formed. Many of these hoods and chimneys are, from faulty construction, practically useless to prevent the fumes escaping into the shop, and those that do succeed in this, do so at the expense of the neighbours as the chimney terminates immediately outside the wall. In the smaller works special shallow furnaces are used. These are provided with bellows to assist combustion. To purify the silver it is treated with crude sal ammoniac, or it is fused in a crucible with 5 per cent. borax and 5 per cent. sodium nitrate, and finally run into moulds.

III.—Recovery of Gold and Silver from Embroidery.

There is a distinct body of men engaged in this trade (*Jarriwálás*). The process adopted by them is one which undoubtedly gives rise to considerable nuisance ; if not indeed danger to health also. The following is an outline of the method. Old clothes and caps, etc., are bought and carefully sorted, and the embroidery removed and washed. This is now burnt and the ashes placed in a flask and a considerable quantity of almost pure nitric acid is added, and the whole gently heated over an open charcoal fire on the floor of the room. This causes evolution of dense, reddish, brown fumes of a very irritating character. These fumes are permitted to escape unchecked into the room. This operation is carried on until these reddish fumes cease to arise, after which the greenish blue liquid in the flask is poured off into a large basin. Fresh acid is now added to the deposit in the flask and the heating process is repeated until all the silver is extracted. The residue or deposit left in the flask is put aside and, by a method to be described later, gold is recovered from it.

Now from the solution of silver in nitric acid, the metal can be recovered by one of two or more processes. Two of these methods may be described.

(*a*) The solution is evaporated and the residue is dissolved in dilute ammonia, and the resulting blue solution is diluted with water to bring the strength of silver down to 2 per cent. A sufficient quantity of normal ammonium sulphite is now added to render the solution colourless on warming and the whole is allowed to stand for 24 hours when 1/3 of the silver separates. If the supernatant solution is now heated to 60° or 70° the remaining 2/3 of the silver separates out.

Or, (*b*) the solution of silver in nitric acid is placed in a large earthenware basin and small pieces of sheet copper are added to it. The silver then becomes deposited on the copper.

The deposit left in the flask after the extraction of the silver is heated in crucibles and from it certain quantities of gold are recovered and run into mould.

IV.—Silver Wire-drawing.

Another industry is that of silver wire-drawing. The silver is first covered with gold leaf and is then heated in a small open furnace in which wood fuel is used. It is drawn cold.

The wires are drawn through gauges of varying calibre. Human labour is used throughout. The majority of premises in which wire-drawing is carried out appear to be used for that purpose only, but some carry on melting and casting as well.

V.—Manufacture of Silver Ornaments, Jewellery, etc.

Silver used in the arts and for coinage is usually alloyed with a small amount of copper, which renders it more durable and more easily worked up. English coins and plate usually contain about 7·5 per cent. of copper. These premises do not appear to cause any nuisance or injury to health to the surrounding inhabitants, in so far as production of vapours is concerned. Certain organic acids are used for cleansing purposes, but do not appear to cause a nuisance.

VI.—Working in Copper, Brass and Aluminium.

Here ornaments and articles for domestic use are manufactured. No nuisance is occasioned from injurious vapours, as the articles are manufactured from sheets of various metals prepared elsewhere. Much noise from hammering etc., arises.

General Remarks.

In the vast majority of cases, the abovementioned processes are carried on on the ground-floor of houses used for habitation. These rooms are often dark and in almost every instance quite inadequately ventilated.

In the process of casting heavy metals, in addition to the products of combustion of the fuel used, large quantities of carbon monoxide and dioxide and the oxides of sulphur must be liberated; occasionally, all of these are permitted to escape directly into the room; and even in those instances where hoods and chimneys are provided, their efficiency in many cases is far from satisfactory.

The melting and refining of silver is carried on generally in rooms quite unsuited for the purpose, the floor being of mud or wood and the walls of wood occasionally. It has already been stated that some of the larger establishments have hoods and chimneys to convey the products of combustion away; but in many of these instances the object aimed at is not often attained: this being due to faulty construction and general disrepair. Another point which must be noted here is that in those cases, where a certain amount of success has attended the efforts to convey the fumes away from the workshop, it is accompanied by a corresponding nuisance to the immediate neighbours, owing to the chimney terminating immediately after passing through the wall. There is evidence also to show that, even where furnaces furnished with a hood, etc., are provided, work is carried on in the same room in furnaces not so protected. Owing to the use of coal and coke as sources of heat, large quantities of the oxides of carbon and sulphur must be evolved, and in the absence of adequate means to carry these products away injury to health must result.

Undoubtedly, however, the greatest nuisance is occasioned by the *Jarriwálás* or those engaged in recovering gold and silver from old embroidery. Here the industry is carried on in small shops in crowded districts in rooms which have no through ventilation. The rooms are usually on the ground-floor of houses used for human habitation. The source of heat is open charcoal fires. The processes carried on result in dense volumes of irritating gases filling the room and escaping therefrom, occasioning nuisance in the neighbourhood. There are no properly constructed fireplaces, the flasks are placed directly on a charcoal fire which is located on the floor, and which may or may not be in close opposition to the wall. No means of escape for the fumes, other than the entrance to the shop, is provided.

Silver wire-drawing in itself occasions no nuisance, nor does the manufacture of articles for domestic use from copper, brass and aluminium. While it is, perhaps, desirable that many of these businesses should be removed to less populous districts in large cities, such a course would tend to dislocate the business of old established firms and would entail great hardship on owners and tenants alike. Such a drastic method could be obviated to a great extent by enforcing certain regulations for the conduct of the business. Such of the owners and tenants as are unwilling or unable to conform to these requirements should be refused a license and compelled to abandon the use of the premises for such a purpose. It is desirable also that no new business be allowed to be established in crowded areas.

It is not possible to frame regulations which would be applicable to all the premises used in these trades alike, and it is necessary therefore that each application for a license be considered on its merits, keeping in view, however, certain main principles directed towards the minimising of nuisance and danger to health of both of those engaged in the work and those living in the neighbourhood.

The following points should be considered in all applications for licenses for the purpose of carrying on the business of lead, iron, copper and brass casting ; smelting and refining of silver ; and recovery of silver and gold from embroidery :—

(1) None of these businesses should be permitted in rooms used for human habitation by day or night.

(2) The structure of the walls and floors should be such as not to present undue risk from fire.

(3) No workshop should be licensed unless provided with adequate *through ventilation*, by means of windows or gratings or both.

(4) No premises should be licensed unless provided with proper fireplaces or furnaces.

As far as possible, such workshops should be situated in premises not used for human habitation. The majority of workshops, however, are situated on the ground-floor of houses so used ; where, therefore, more suitable accommodation is available, pressure should be brought on these to remove. Where, however, such is not, certain measures for the purpose of minimising the risk of nuisance should be insisted on and no workshop used for these trades should be permitted in houses used for human habitation, unless for each furnace there is provided and applied *and used* a hood of sufficient size to collect the fumes arising; this hood to communicate directly with a chimney which may be of metal or other suitable material, and which must be of sufficient length to permit of the discharge of the fumes in such a manner as to cause no nuisance. Further, it should be provided that hood and chimney at all times be maintained in a good state of repair.

In no instance should the chimney be allowed to terminate in close proximity to a window.

In those cases where, from the situation of the premises or other cause, it is impossible to provide for the fumes to escape by means of a chimney discharging directly into the open air, provision should be made for the destruction of the gases by conducting them into or under a fire or by condensation in water. Where none of these methods or other suitable method is available, the premises should be considered unfit for the purpose.

Another method of obviating the nuisance from these smelteries is to keep the flasks in a brick chamber during the boiling operation. The chamber should be fitted with a chimney carried to a sufficient height to prevent any nuisance to the adjoining houses. The chamber may be built of ordinary bricks, as there is not sufficient heat given off by the charcoal to necessitate the use of fire-bricks.

THE PRESSING OF OIL SEEDS.

A very extensive trade in the extraction of oil from seeds is carried on in Bombay and other cities in India. *Til*, cocoanut, and ground-nut oils are the principal oils extracted. They are all edible oils and are largely used as substitutes for ghee.

For the most part very primitive and wasteful wooden presses are used, worked by a pair of bullocks working in turn, and driven by a man who sits on the press and feeds it from time to time with the material to be crushed. There is no inherent nuisance associated with the trade itself, but under the conditions in which it is carried on, in practice much nuisance does result. This is due to the fact that the great proportion of these oil-presses or *ghánis* are located on the ground-floor of inhabited houses. The rooms are practically devoid of light and ventilation, except such as may be obtained through the door. The spare bullock or bullocks are generally stabled in a corner of the room, the floor of which is unpaved and undrained and generally maintained in a state of filth. As a rule, the workmen and their families also live in the room.

In many of the rooms there is no through ventilation and the size thereof is so small as to occasion a considerable amount of cruelty to the animals.

The amount of oil extracted from *til* seed is about 40 per cent. and from cocoanut about 60 per cent. The solid residue is used for feeding animals.

To obviate the nuisance, the best measure is to adopt mechanical power in working the *ghání*, where the business is of such dimensions as to render such a change financially possible. Failing this, no license should be given to work an oil *ghání* by bullocks in a crowded neighbourhood or in any room of a dwelling house. Where bullocks are used, properly paved, drained and ventilated stabling accommodation should be insisted upon.

PARCHED RICE.

Parched rice or *Kurmura* is largely consumed by the poor, and also as "refreshments" by school children during the mid-day recess.

The process of making this article of food is generally carried on in an ordinary cudjan shed which contains several ovens, the number of the latter varying with the length of the shed.

The ovens are built of *kutcha* bricks and mud, and thickly smeared over with dung. They are circular in shape and have an opening on the top into which is fixed an iron pan of varying size. There are no chimneys, but at the back of each oven, there is a large slit, two feet in height and six inches in width, which acts as a kind of flue and also serves the purpose of feeding the fire.

The fuel used consists of the husks of rice, saw-dust and thin stalks of hay. As the fire is fed through the slits, an outward draught takes place, which brings out a good deal of smoke. In fact, when all the ovens are lighted, the smoke nuisance is considerable owing to the kind of fuel used.

The rice used is of very inferior quality. It is first soaked with the husks on it in boiling water in a wooden tub. This soaking lasts for 15 hours. Then the rice is sieved out by means of iron sieves, and placed in a smaller dry wooden tub, perforated with holes at the bottom, to allow of the water in the soaked grain to be completely drained off. The next process is to subject it to a partial baking in the iron pans placed at the top of the ovens. After this, the rice is placed on mats and allowed to dry in the sun. It is next threshed out in large wooden chalises by being beaten with thick sticks, at both ends of which are iron caps. When the husks are fully removed, the rice is treated with salt dissolved in water, and then it undergoes final baking in the iron pans on the ovens. This baking lasts for 3 hours and in order to prevent the rice from being burnt it is mixed with a certain proportion of sand.

There is no cleanliness observed in the whole process of making this parched rice; the tubes and other utensils are rarely cleaned before use. The shed in which this business is carried on is used for dwelling purpose as well, and great danger of contaminating this food arises when any cases of Cholera or Enteric Fever take place among the persons residing in this shed. They all sleep on the very floor where the rice is spread out and threshed, and this floor is made of earth smeared over with dung.

This trade ought to be carried out in decent well ventilated sheds which should not be used for human habitation.

EATING HOUSES.

There is a very large number of eating houses in Bombay and other cities in India. These places play an important part in the lives of the poorer working classes, and the low-paid and unmarried populace, for whom these houses for the most part cater, have to rely on them for their daily food. This fact alone is sufficient justification for demanding that a certain minimum standard of sanitation in regard to these eating houses should be compulsory. But unfortunately these places, so far as Bombay is concerned, are not directly under the control of the Health Department and there is no section of the Municipal Act under which sanitary requirements in regard to them can be enforced.

As matters stand at present, a large number of eating houses exist in the City of Bombay in highly objectionable and insanitary surroundings. Those which are open between the hours of 9 p.m. and 5 a.m. require to be licensed by the Commissioner of Police, and that officer has agreed to give the Health Department an opportunity of stating the requirements which would render, such premises for which licenses are demanded, sanitary. In this way a few at least of the sanitary requirements can be enforced in such eating houses. Those houses, however, which are open only up to 9 p.m. require no license from the Police, and the Health Department is unable to enforce sanitary arrangements in them. For the safety of the health of a very large portion of the population of the City, who resort to such places, it is necessary to control the conditions under which food is prepared there. For this purpose it has been proposed to include the "Keeping of Eating Houses" in the list of trades specified in Part IV of Schedule M of Section 394 of the Municipal Act, and to have the following definition of the term "Eating Houses" inserted in the Act :—

"Eating House" means "any premises to which the "public are admitted and where any kind of food is prepared or supplied for consumption on the premises for the "profit or gain of any person owning or having an interest "in or managing such premises."

This proposal is at the present moment being considered by the Corporation, who, no doubt, will make the necessary representation to Government in due course to amend the Municipal Act in the desired direction, and when it becomes law it will be possible not only to control the regular eating-houses, but also the conditions under which other kinds of food, such as native sweets, are prepared.

It will not be out of place here to point out some of the most glaring defects that have been noticed in the large majority of these poor class eating houses and the remedies which are necessary to make them sanitary.

As mentioned above, these houses are at present licensed by the Police, and such licenses are granted indiscriminately without reference to the suitability or otherwise of the place and its surroundings for the purpose of preparing food for human consumption.

In the majority of cases, there is but one eating room or restaurant proper, which may or may not communicate directly or indirectly with the cook-room. Chiefly, however, it does so directly, and in some instances performs the dual function. With a few creditable exceptions, the general impression in regard to those eating rooms is one of filth everywhere—filth on the floor, filth on the walls and filth on the ceilings.

Some eating rooms are used as sleeping apartments for those employed in the business or by the family of the proprietor. In the majority of instances, the floors are properly paved, but in some instances they are rammed with earth and smeared over with cow-dung. The importance of a clean floor is better appreciated when one remembers that many of the customers take their meals while sitting on the floor, and in some instances the food is actually prepared there. The lighting and ventilation of many of the eating rooms are far from satisfactory. The incoming air is frequently derived from a vitiated source, such as a common gully choked with garbage in varying degrees of decomposition and bordered by basket privies. Another and most frequent cause of bad ventilation is the cook-room fire, for whose smoke there is no exit other than the main door and windows.

In some of the eating rooms marble-topped tables are used which are capable of being properly cleansed. In other instances wooden tables covered with oil-cloth or linoleum are in use, whilst in others plain wooden tables coated with the grease of ages.

Cook-rooms: The first essential of a cook-room is that it should be well-lighted and adequately ventilated. But in the majority of eating houses, cook-rooms form part of the general eating-rooms, or are generally very badly lighted and ventilated. In a few instances the *chowk* or interior open space of the house is used as a cook-room, an arrangement hardly contemplated at the time of building the house, as presumably the *chowk* is meant to act as a ventilating shaft for the upper floors. But the climax would appear to be reached when we find actually in the cook-room itself, or in close relation to it, basket privies. In one notable instance in the outlying districts of Bombay the sweeper has to pass through the cook-room with his basket of night-soil to get at and clean the privy receptacle!

Apart from the general appearance of filth due to waste vegetable and animal matter and grease lying on the floor and walls, and to the smoke-begrimed walls and ceilings, additional dirt is caused by the careless storing of the coke and charcoal used in cooking. Any odd corner, or even the table, is considered suitable for storage.

The tables on which the food is prepared are open to grave criticism, and it is a matter of rarity to come across one which has been subjected to a course of soap and water within recent times. In some instances no table is used, but merely a dirty plank. In fact, there is no doubt that the condition of the cook-rooms and the method of conducting the business of preparing food for human consumption is little short of scandalous, more specially in view of the fact that these houses are licensed. Such a title should be a guarantee of reasonable cleanliness but, one must confess that as far as one has been able to determine, the only guarantee conveyed by the license is the payment of a small fee for the privilege of dispensing food under grossly insanitary conditions.

Water-supply: In studying the water-supply of these poor class restaurants, one meets with an excellent example of the inconvenience and dangers attendant on an intermittent water-supply system. In practically every licensed house Municipal water is laid on, but as the restaurant is open all day and the supply is not constant, various devices are resorted to to lay in a stock sufficient for the non-supply hours. Every conceivable utensil is pressed into service. The most popular method of storage, however, is a large wooden tub or barrel which may or may not be closed at the top. Many of these barrels are in places very difficult of access, a point which militates against the probability of daily cleansing, and others are placed as near drain inlets as possible, or within a few feet of a basket privy.

Cleansing of dishes, etc.: Here also a great variety of practices obtains. In some houses a proper washing tray is used, consisting of a wooden table with raised edges, the whole being covered with zinc. Some of these tables discharge over or near properly trapped drain inlets, others are connected to storm-water drains, while many simply discharge on to the public road. In other houses the *nahani* is used for this purpose. The house gully is used by some for washing dishes, whilst others use a bucket. In certain restaurants the condition of the vessels would lead one to believe that any attempt even at cleansing vessels is unknown.

Removal of waste food and water and sweepings: The almost total absence of any attempt towards an organised method of removal of waste products and sweepings is one of the conspicuous features of this trade. Practically all the eating houses show evidence of neglect in the shape of unswept floors and tables strewn with waste food, of kitchens littered with scraps of meat or fish or waste vegetable matter. There is no proper receptacle kept for the purpose.

None of the premises contains any provision for the proper storage of milk, meat or any article of food. The milk is usually placed on the floor in an uncovered vessel, and occasionally as a precautionary measure a wisp of hay is packed into the mouth of the vessel, presumably to keep the dirt out. Meat is disposed of anywhere on the floor or table or hangs from the ceiling covered with flies.

The following conditions are now being gradually enforced in the case of eating houses, with the help of the Police, in order to render them fit and sanitary:—

(*a*) The licensee shall provide and maintain in good repair and use a metal sanitary dust-bin of approved pattern and provided with a lid. This dust-bin should be in daily use for the storage of waste food and sweepings of the floor, and the contents should be emptied daily into the nearest Municipal dust cart.

(*b*) The licensee shall provide a table or tables for the eating house proper. Such table or tables should be marble-topped or of wood covered with zinc on the upper surface or with such other non-absorbent metal as may be approved by the Municipal Commissioner. Similarly, the licensee should provide one or more tables for use in the kitchen, such table or tables to be covered with zinc in every case.

(*c*) The licensee should provide and use a metal bin or metal-lined wooden bin for the storage of any coal, coke, charcoal or firewood used in the preparation of food. Such bin to be located in a situation approved of by the Deputy Health Officer. (This provision is insisted upon in bake-houses in England).

(*d*) The floor of every cook-room and eating room should be paved or cemented.

(*e*) The walls of every cook-room and eating room shall be lime-washed twice yearly, and the woodwork thereof shall be washed with hot water and soap at least once every twelve months.

(*f*) Every licensed eating house should provide a receptacle of a standard pattern for the storage of water during non-supply hours. This receptacle should be fixed in a definite position approved of by the

Deputy Health Officer, who will be guided by the proximity or otherwise of drains, or drain inlets gullies, etc.

(*g*) The milk, meat and other articles of food should not be allowed to lie exposed but should be stored in proper meat-safes or cupboards.

(*h*) Every licensed eating house should be provided with a proper washing place for cleansing dishes, cups, etc., used in the business. Such washing place should be properly drained and discharge over a half channel gully at a point at least 18 inches away from any drain inlet.

(*i*) Every licensed eating house should be well-lighted and well-ventilated, and should at all times be kept scrupulously clean.

SWEETMEAT SHOPS.

As is the case with eating houses, a very large number of sweatmeat shops exist in the City of Bombay in highly objectionable and insanitary surroundings. As the law stands at present these places are not under any control, although they play an important part in the lives of many persons, as sweets form part of the daily food of many individuals in India.

The principal Indian sweets are *Halva, Ladoo, Julebee, Penda* and *Burfee.*

Halva is a viscous substance. It is made by soaking wheat for three days in a tub and then kneading the same. This process of kneading is generally carried on by means of naked feet, and the precaution of washing the feet before employing them for this purpose is the exception rather than the rule. After this the whole is strained through cloth and washed, and the residue which is glutin is mixed with sugar and various spices and also flavoured with vanilla and other essences. The whole is then boiled in ghee, and afterwards laid on wooden slabs and cut in slices.

Ladoos :—These are either round or cone-shaped. They are made from gram flour, which is first mixed with water.

This mixture is next sieved through an iron pan, the contents being dropped into a frying pan, full of sweet oil or ghee, and placed over a fire. The fried contents which appear like vermicelli are then mixed with sugar and spices and made into round or cone-shaped balls.

Julebee:—Wheat flour is mixed with water and allowed to stand for some hours. It is then stirred and mixed into a proper paste. This is then placed in a copper *lota* which is perforated with a single hole at the bottom. The *lota* is next held over a frying pan containing ghee and the contents are dropped into it through the hole in the form of circles. These are then dipped into a pan containing simple syrup and afterwards placed in copper or brass plates.

Penda and *Burfee* are purely milk preparations. The milk is first made into what is known as *mawa.* This *mawa* mostly comes from Surat and other places in Gujerat and it frequently becomes stale by the time it arrives here.

The large majority of these sweetmeat shops are located on the ground floor of dwelling houses. The process of frying is carried on in open fire places, without any provision for the escape of smoke by means of chimneys. The smoke nuisance and the smell of frying ghee or oil are rendered still more objectionable by the trade being carried on in dark ill-ventilated rooms. There is little cleanliness observed in the making of the sweets. Everything is done on the bare floor. There are no proper tables or even benches. The sweets are exposed in open trays for sale and flies are allowed to swarm over them in large numbers.

It is necessary for the safety of public health to control the conditions under which sweets are prepared at these places. Such places require to be licensed under conditions somewhat similar to those laid down in the case of eating houses.

AERATED WATER FACTORIES.

Along with bake-houses, ærated water factories have also to be licensed in Bombay City under Section 394 (1) (*d*) (*i*). It has always been recognised that, if a supply of ærated waters prepared under wholesome conditions is to be looked for, such factories must be licensed or registered; and ever since they have thus been brought under proper sanitary control, many improvements have been effected in them.

Prior to the introduction of this legislation, it was found that very few ærated water factories in Bombay fulfilled even ordinary sanitary conditions. The factory premises, as a rule, were found to be unsuitable for the purpose as regards position, construction, light and ventilation. The water-supply was stored in receptacles which were open to contamination. The dirty bottles were washed in tubs containing water, which, though it may be clean to start with, speedily became very foul and the whole business of the production and handling of the ærated waters was conducted without proper regard to cleanliness.

It is not only desirable but necessary in the public interest that certain structural and sanitary standards should be insisted upon in respect of premises used as ærated water factories, and the following requirements are now demanded in the case of all such factories.

(1) The building should possess the conditions of wholesomeness needed for dwellings in general and should further have arrangements fitting it for the special purpose of an ærated water factory.

(2) The rooms should be light, airy and well ventilated, and the floors and walls should have a smooth and non-absorbent surface that can be easily cleaned.

(3) No drain or pipe directly communicating with a house drain or sewer should have an opening in the factory, and the factory should not have any windows or ventilation openings abutting on a sweeper's passage, and should not be situated near a privy or other potential source of contamination.

(4) The water supply of the factory should be from a service pipe connected to the Municipal main, or from a special covered cistern supplied with Municipal water, and so located as to admit of its being readily cleaned.

(5) The brushes used for scrubbing the interior of dirty bottles should themselves be cleaned and disinfected periodically, and the washing and the cleaning of the bottles should be carried out in running water or by means of a jet of water at high pressure.

(6) No person should be permitted to sleep in any part of the factory.

(7) The utmost cleanliness should be observed in the various processes of manufacture and the premises and appliances should be kept in a thoroughly clean and sanitary condition.

BAKE-HOUSES.

As defined in the Public Health (London) Act of 1891, a "bake-house" means any place in which are baked bread, biscuits, or confectionery, from the baking of which a profit is derived. This definition is proposed to be adopted in the Bombay Municipal Act.

In large cities the sanitary control of bake-houses is a public necessity; it is more so in India, where bread and biscuit making is in many instances carried on in insanitary buildings and surroundings. Many of these establishments are such as are likely on occasions to become infected with the specific organisms of certain diseases, *e. g.*, Cholera, Enteric Fever and Tuberculosis, and such germs can easily be conveyed to the dough either by the air, by utensils, by the agency of flies, or by the hands of workmen. It is, of course, true that, from the consumers' point of view, the evils of insanitary bake-houses are to some extent counteracted by the process of baking, but carefully conducted bacteriological experiments have shown conclusively that baking does not necessarily destroy all the germs that may be contained in dough. Moreover, bread when taken from the oven is often allowed to lie about the bake-house for a considerable time, and there is then every chance of the crust becoming contaminated in one or more of the ways mentioned above. The insanitary bake-house is, therefore, a source of danger both to the bread-consumer and the bread-producer, and in the interest alike of the public and the workmen certain structural and sanitary standards are obviously necessary in respect of premises used as bake-houses. These are briefly as follows :—

The building should possess the conditions of wholesomeness needed for dwellings in general, and should further have arrangements fitting it for the special purpose of a bake-house. Separate rooms should be provided for storing flour, for mixing and kneading the dough, for baking, and for storing the bread. The rooms should be light, airy and well ventilated, and the floors and walls should have a smooth and non-absorbent surface that can be easily cleaned. The dough troughs and kneading tables should preferably be of glazed iron and movable, so as to admit of ready cleansing with water. If made of wood, the inner surface should be smooth and free from cracks, so as to prevent the lodgment of dough and putrescible material. The oven should be so arranged that none of the fumes can escape into the room in which it opens, and the chimney should be of sufficient height. The bread when baked should be taken to a special room and kept in such a way as to protect it from contamination. A special lavatory should be provided for the work-people and it should not communicate directly with the bake-house, but should be quite detached. No drain or pipe directly communicating with a house drain or sewer should have an opening in the bake-house, and the bake-house should not have any windows or ventilation openings abutting on a sweeper's passage and should not be situated near a privy or other potential source of contamination. The water supply of the bakery should be from a service pipe connected to the Municipal main, or from a special cistern so located as to admit of its being readily cleansed. No person should be permitted to sleep in any part of the bake-house, and no room on the same level as the bake-house and forming part of the same building should be used as a sleeping place, unless effectually separated from the bake-house by a masonry partition extending from the floor to the ceiling. Lastly, the utmost cleanliness should be observed in the various processes of bread-making, and the premises and appliances should be kept in a thoroughly clean and sanitary condition.

Under Section 394 of the City of Bombay Municipal Act, no place can be used as a bake-house unless it is licensed, and the provisions mentioned above are being gradually enforced in the case of all such establishments where bread, biscuits, etc., are prepared on a large scale. But besides these regular bakeries, there is a number of small shops in *chawls* and dwelling houses at which biscuits, etc., are prepared in small quantities and sold on the spot. The rooms are partly used for human habitation, and in each of them there is an oven without any out-let for smoke. In such places the flour is kneaded in iron or tin trays, which are afterwards covered over with more or less dirty gunny bags to protect the unbaked biscuits from dust and flies.

Such small bakeries are somewhat akin to what are described as "retail bake-houses" in Section 102 of Part V of the English Factory and Workshop Act, 1901. They cannot be expected to be brought all at once up to the European standard, and in their case the following requirements are demanded with a view to ensure, as far as possible, the preparation of bread and biscuits under fairly wholesome and sanitary conditions :—

(*a*) All the walls and ceiling of such a bake-house should be limewashed three times a year, in the months of January, May and September.

(*b*) The floor of the room should be paved with fine dressed stone slabs, cement or tiles.

(*c*) The place should not be used as a sleeping room.

(*d*) No water-closet or privy should be within the bake-house or communicate directly with it. There should be separate cisterns for water-supply from the cisterns supplying water-closets. There should be no drain connected with sewer inside the bake-house.

(*e*) The kneading of the flour should be done on clean, smooth, wooden, zinc or marble tables.

(*f*) The flour should be stored in bags, which should not be placed on the ground but on a bench or table.

(*g*) The size of the oven should be such that it should occupy less than half the accommodation in the room; and it should be provided with a suitable chimney.

Sec. 394 *of the City of Bombay Municipal Act.*

394. (1) Except under a license granted by the Commissioner no person shall—

(*a*) keep in or upon any premises for any purpose whatever—

(*i*) any article specified in Part I of Schedule M, *viz.*,

Blood,
Dynamite,
Fulminate of mercury,
Gun-cotton,
Blasting powder,
Nitro-glycerine.

(*ii*) any article specified in Part II of Schedule M, in excess of the quantity therein prescribed as the maximum quantity of such article which may at any one time be kept in or upon the same premises without a license;

Chemicals.	..4 gallons.
Cotton refuse	..4 bags not exceeding 4 cwts.
Cotton seed	..4 bags not exceeding 4 cwts.
Gunpowder	..5 lbs.
Matches for lighting ..	..1 gross boxes.
Petroleum, as defined in the Indian Petroleum Act, 1899	..40 gallons.
Dangerous Petroleums as defined in the same Act	..20 gallons.
Oil (other sorts).. ..	..15 gallons.
Saltpetre	.. ¼ cwt.
Tar, pitch or dammer ..	.. ½ cwt.
Turpentine	.. 1 gallon.

(*b*) keep in or upon any premises, for sale or for other than domestic use, any article specified in Part III of Schedule M, *viz.*,—

Ashes,
Bones,
Carbide of calcium,
Charcoal,
China grass,
Coal,
Cocoanut fibre,
Coke,
Fat,
Fins,
Fireworks,
Firewood,
Fish (dried),
Flax,
Grass,
Hair,
Hay,
Hemp,
Hides (raw),
Hides (dried),
Hoofs,
Horns,
Jute,
Offal,
Rags,
Skins,
Straw,
Tallow,
Timber,
Wool (raw).

(*c*) keep or allow to be kept, in or upon any premises, horses, cattle or other four-footed animals

(*i*) for sale,

(*ii*) for letting out on hire,

(*iii*) for any purpose for which any charge is made or any remuneration is received, or

(*iv*) for sale of any produce thereof;

(*d*) carry on, or allow to be carried on, in or upon any premises—

(*i*) any of the trades or operations connected with trade specified in Part IV of Schedule M, *viz* :—

Baking,

Casting Metals,

Dyeing cloth or yarn in indigo or other colour,

Tanning, pressing or packing hides or skins, whether raw or dried.

Manufacturing, packing, pressing, cleaning, cleansing or preparing by any process whatever any of the following articles—

Ærated Waters.
Bricks or tiles.
Catgut.
Bones.
Candles.
Cotton or cotton refuse or cotton seed.
Lime.
Oil-cloth.
Pitch.
Offal.
Paper.
Pottery.
Cowdung-cakes.
Fat.
Gas.
Dammer.
Flax.
Ghee.
Rags.
Sugar.
Tar.
Soap.
Tallow.
Wood.

(*ii*) any trade or operation which in the opinion of the Commissioner is dangerous to life, health or property, or likely to create a nuisance either from its nature, or by reason of the manner in which, or the conditions under which, the same is, or is proposed to be carried on.

(2) A person shall be deemed to have known that a trade or operation is, in the opinion of the Commissioner, dangerous or likely to create a nuisance within the meaning of paragraph (*ii*) of clause (*d*) of sub-section (1), after written notice to that effect, signed by the Commissioner, has been served on such person or affixed to the premises to which it relates.

(3) It shall be in the discretion of the Commissioner—

(*a*) to grant any license referred to in sub-section (1), subject to such restrictions or conditions (if any) as he shall think fit to prescribe, or

(*b*) to withhold any such license.

(4) Every person, to whom a license is granted by the Commissioner under sub-section (3), shall keep such license in or upon the premises to which it relates.

(5) Nothing in this section shall be deemed to apply to mills for spinning or weaving cotton, wool, silk or jute or to any other large mill or factory which the Commissioner may from time to time with the approval of the Standing Committee specially exempt from the operation thereof.

CHAPTER X.

SCHOOL HYGIENE AND MEDICAL INSPECTION OF SCHOOLS.

SCHOOL HYGIENE.

The question of school hygiene and its importance in regard to the welfare of the nation is coming into prominence, as its far-reaching influence is more fully appreciated by the public. The latter now realise that attendance at school is necessary not only for the purpose of acquiring varying degrees of proficiency in the subjects usually embraced by school curricula but also, concurrent with the absorption of such knowledge, the student should learn how to live: in fact, that he should acquire at least an elementary knowledge of personal and domestic hygiene and thus be enabled to appreciate his duties both to himself and family and also to his neighbours.

For two reasons at least, therefore, school premises should be constructed and maintained in a high degree of efficiency; first, in order that the present and future health of the scholars may in no way be prejudiced; and, secondly, that by the constant association of school life with order, cleanliness, good ventilation and general high standard of sanitation, the student may acquire, both by practice and precept, a knowledge of the value of such surroundings and be the better able to reach and maintain a similar standard in his own home and vicinity. Practically, all the great cities of England are now spending large sums in educating a generation who had not the advantages now offered to the elementary-school boy, imparting to them the simple fact that cleanliness, free ventilation and light are the three principal agents in reducing sickness and death-rate.

The present generation of scholars are more fortunately situated in that they are acquiring that knowledge at a period of life when the impression conveyed is more apt to take root and be remembered.

Apart altogether, however, from the educational value of good schools, such institutions not only promote the growth of healthy children, but very greatly diminish the spread of the zymotic diseases, so fatal to childhood, and of contagious diseases, such as ringworm, ophthalmia, scabies, etc. The influence on eye-sight will be discussed later under the heading "Light and Ventilation."

Site and surroundings.—In choosing a site for a new school, one of the first considerations is that it should be so located as to afford easy means of access to the scholars attending it, and consequently be in a more or less central position. A noisy site is particularly undesirable not only on account of the difficulty in teaching but also because of the natural lack of concentration of thought in young children. For this reason for all new schools a quiet site should be selected, and if such cannot be obtained the building should, if possible, be set back from the main street, preferably 60 feet at least.

In Indian towns many schools are situated in *chawls* or over shops or factories, in main thoroughfares, where throughout the day the noise of traffic, of itinerant vendors, or of trade processes serves to distract the already feeble attention of the child from the subject in hand. Others again are in close proximity to basket privies, wood depôts, milch cattle stables and *dhobi-ghats*.

Of course, it must be recognised that the majority of buildings or parts thereof occupied as schools in India were not originally constructed for that purpose, but have been rented probably on account of convenience of situation and lack of the necessary funds for erecting more modern buildings. One cannot however but record the impression that those considerations have out-weighed the necessity for due concern as to the physical welfare of the scholars, and that buildings have been occupied as schools which are totally unsuited to the purpose.

In regard to the construction of new schools it may be taken that the site area should average ¼ acre for every 250 children. The modern tendency is to have a large central hall in which all the scholars can meet, and from this hall class rooms open. Where ground space is not of prime consideration, this central hall may be completely isolated from the class rooms but, where the site is limited, the hall should be separated from the class rooms by corridors open to natural ventilation. In either instance the hall should be of such a size as to give a floor space of 4 square feet per scholar and be thoroughly well lighted and ventilated. Where ground is cheap and available, all the class rooms should be on the ground floor but, as in large cities this is practically impossible, upper storeys must be provided, though it is desirable that a public elementary school should not exceed two storeys in height.

In India advantage should be taken of the climate and "open air" classes encouraged as much as possible.

Cubic space per head.—In regard to the proper allowance of cubic space per head, much will depend on the climate. In colder climates a greater allowance of cubic space per head must be made, since the removal of the air cannot be carried out so often in any given time as in the warmer climates, unless the air be artifically heated prior to introduction into the school-room. The minimum cubic space laid down by the Educational Department in England is 100 cubic feet per head, while the London School Board require 130 cubic feet. Even this amount is on the small side, and Newsholme, Medical Adviser to the Local Government Board, considers that 150 cubic feet should be the minimum.

On examining 125 schools in Bombay, judged by the standard of the English Education Department, no less than 61·4 per cent. of the schools fall below the requirement, *viz.*, 100 cubic feet per head. Even if we make allowance for the difference in climate and adopt 90 cubic feet per head as a minimum, we still find a large number of schools with quite inadequate space. In some instances the cubic space per head falls as low as 20 cubic feet. In nine cases it is below 40 cubic feet, and in 15 instances the cubic space provided is between 40 and 50 cubic feet. The significance of these figures will be dealt with under ventilation.

Floor area per head.—Under the English Education requirements 10 square feet per head must be provided, and for infants an average of not less than 9 square feet is accepted. Newsholme suggests as a minimum 15 square feet. Taking the requirements to be 10 square feet, we find that 64·8 of the Bombay Schools fail to reach this standard, and in one instance the amount provided is as low as 3.1 square feet, an amount totally incompatible with proper ventilation and personal comfort.

Light and Ventilation.

Light.—The importance of good light cannot be overestimated, as any deficiency thereof is one of the chief causes of defective sight. The focal length of the normal eye for reading all ordinary type is about 12 to 14 inches, and for writing about 14 to 16 or 18 inches according to the size and character of the writing. If the light be defective, the scholar, not being able to read clearly at the proper distance, stoops to lessen the distance, with the result that the eyes converge and the muscular strain thus produced leads to a gradual elongation of the antero-posterior axis of the eye-ball resulting in Myopia, *i.e.*, the image of the object seen forms in front of the retina (unless the object itself is very close to the eyes) and is very blurred and indistinct. Moreover, holding the head down over the book or paper tends to congestion of the vessels of the eye and general impairment of sight.

In any room the light should come directly from the sky, and no part of a room may be deemed sufficiently lighted from which a certain extent of the sky cannot be seen. In large cities it is of course a matter of great difficulty sometimes to obtain this standard. In a building of several storeys high forming part of a street, the opposite houses of which are of the same height, each room is divided into two regions of different degrees of illumination by a plane formed by a line drawn from the ridge of the roofs of the opposite buildings and the upper borders of the windows; below this plane the light is sufficient or, at any rate, is skylight, above it is insufficient, being diffused and reflected, not direct. In the upper rooms of the buildings this plane strikes the opposite wall and in these rooms the whole of the occupied part of the room is in the light, but in the lower rooms this plane falls not on the wall but on the floor and a greater or less portion of the floor space will be in relative darkness and unfit for reading, writing or needlework. Now, the intensity of the light in a room depends on two factors : (1) *the angle of incidence*. Forster is of opinion that light should fall on the floor at an angle of no less than 25°, as the intensity diminishes inversely as the square of the area over which it is distributed, the increased obliquity of the incident rays reducing the intensity of the light; and (2) *the angle of aperture,* or the arc of sky visible at any given point in the room. This angle is greatest in the upper rooms and diminishes as we proceed downwards, until on the ground floor it may vanish altogether. It should never be less than 5° of an arc in any part of the room. The necessary amplitude of angular aperture is to be sought by increasing the height of the rooms, by carrying the window heads nearly to the level of the ceiling, (the sills being 4 or 5 feet above the floor), by regulating the width of the rooms (this should on no account be greater than 2½ times the height of the window heads from the floor, which ratio gives an angle of 25° to the rays reaching the floor on the farther side of the room) and lastly, by avoiding the proximity of buildings on the side from which light is derived.

Under modern conditions of life, specially in towns, one of the most important problems is how to obtain a sufficiency of light and air. The usual practice is to adjust the height of buildings to the width of the streets ; but the orientation of a street seriously affects the incidence of the sun's rays, even in the same degree of latitude. Sir Shirley Murphy, in 1898, published tables showing the width in feet of the streets in the latitude of London necessary to secure 1 to 6 hours' sunlight upon houses 40 feet high, situated in streets orientated north and south and at an angle with the meridian increasing by 5° until reaching 90°, *i.e.*, orientated east and west. The facts show that in the latitude of London at least, streets as wide as the houses are high will secure 6 hours' sunshine at the summer solstice in streets at all angles to the meridian ; and 4 hours' sunshine in meridional streets at the equinoxes. If the width be increased to 1½ times the height of the houses, six hours' sunshine will be secured in all streets at the equinoxes and 3 hours' sunshine in meridional streets at the winter solstice. If we limit the height of the houses to the width of the street, an angle of 45° is reached in London by the sun's rays in the first weeks of April and September, so that for 5 months the rays are above this angle and for 7 months below it.

The London Building Act of 1894 prohibits the raising of buildings in streets laid out since 1826 higher than the width of the street.

As regards light and air in the rear, by the same Act an angle of 63½° is provided for.

The Bombay Municipal Act provides for an angle of 45° in regard to new houses. This angle predominates in many continental cities also.

This rule,however, applies to frontages only, and if all class-rooms abutted on a frontage the light would perhaps be sufficient, but in many of the rooms in Indian schools the light is derived not from a frontage but from a side gully, or even in some instances *via* another room. In such a case the angle of aperture is *nil*, it being a physical impossibility to see the sky from any portion of the interior of the room.

In other cases the only light available comes from directly in front of the scholars. As a general rule, so long as light does not fall on the eyes either directly or by reflection, it can scarely be too strong. The admission of direct sunshine into a school-room is undesirable and for this reason a southerly aspect is to be deprecated unless there are windows on the north side also, in which case the former may be of ground or tinted glass. If the window space be ample and there be no obstructive buildings, a north light is agreeable ; windows facing east and west are to be recommended, since in rooms so arranged there is no direct sunlight during school hours for the greater part of the year.

In schools the seats should be so arranged that the strongest light comes from the left hand side of the scholar ; when such light is impossible, the next best is right light. Windows full in the face of the scholar are most objectionable. This is a point to which but little attention seems to be paid in Indian schools. The window sills should be placed not more than 4 feet above the floor, and the window should reach nearly to the ceiling and be made to open direct into the external air. Although opposed by some, a strong argument in favour of cross-lighting from east and west is that the angles formed by the rays of the light with the floor from opposite sides are added and the intensity of the light is thereby doubled.

Ventilation.—As is well-known, the ordinary atmosphere contains about 4·04 per cent. of carbon dioxide gas, and ordinary expired air 4·04 per cent. that is to say 4 per cent. of CO_2 is given off in each breath. In the case of an adult male, at each breath 30.5 cubic inches of air pass in and out of the lungs containing, when expired, an additional 4 per cent. of CO_2, or $\frac{4 \times 30{\cdot}5}{100} = 1{\cdot}22$ cubic inches of CO_2; assuming an average of 17 respirations per minute or 1,020 respirations per hour, then $\frac{1{\cdot}22 \times 1{,}020}{1{,}728} = 0{\cdot}72$ cubic foot of CO_2 per hour. Women and children inhale rather less, and for children the amount averages about 0·4 cubic foot. For a mixed assembly of men, women and children 0·6 is taken as the amount. Now the total CO_2 in a room should not exceed 0·6 part per 1,000, and since ordinary atmospheric air contains 0·4 part per 1,000, it follows that the amount of added respiratory impurity should not exceed 0·6—0·4 =0·2 part per 1,000. Now to fulfil these conditions a certain amount of fresh air per head per hour should be introduced, and the amount (D) can easily be calculated if (E) the total amount of CO_2 inhaled and (R) the added respiratory impurity in one cubic foot of air be given then

$$\therefore D = \frac{E}{R}$$

now E=0·6 cubic foot per hour,

and R=0·2 per 1,000 (or 0·0002 per cubic foot.)

$$\therefore D = \frac{0{\cdot}6}{0{\cdot}0002} = 3{,}000.$$

That is to say, each person should be allowed 3,000 cubic feet of fresh air per hour if the limit of permissible respiratory impurity is not to be exceeded. This is for a mixed community. For children during repose about 2,000 cubic feet per head per hour are required. This is the theoretical standard that has usually been accepted by all authorities, but Haldane and others have suggested that, instead of taking 0·6 cubic feet of CO_2 per 1,000 as the limit, the standard should be 1·0 for dwellings and 1·3 for schools. This would allow of added respiratory impurity of 0·6 in the former and 0·9 for the latter in place of DeChanmout's general limit of 0·2. On this basis the bare need of fresh air in dwellings would not exceed 1,000 cubic feet per head and in schools be but 550 cubic feet. Experience so far has not justified the general acceptance of these low standards.

The larger the air space the less is the necessity for the frequent renewal of air and the less the chances of draught. Thus a space of 100 cubic feet must have its air changed 30 times in an hour if 3,000 cubic feet are to be given, while a space of 1,000 cubic feet need only have it changed three times. The warmth of the moving air greatly influences the sensations of the persons exposed to it. At the temperature of 60° Fahrenheit, a rate of 1½ feet per second is not perceived; 3 feet per second is perceptible to most and a rate of 3½ is perceived by all, and any greater speed than this will give a sensation of draught. If the air be about 70° a rather greater velocity is not perceived, while if it be still higher—80°—90° Fahrenheit—the movement becomes again more perceptible. In the climate experienced in Bombay, the change of air could be carried out at considerably greater speed than in a colder country and consequently a smaller initial cubic space is required. Considerations of expense render it practically impossible to provide the theoretical amount necessary, *viz.*, 1,000 cubic feet of space per head. In Canadian schools an allowance of 250 cubic feet per scholar is insisted upon; in Poor Law schools in England 360 cubic feet; common lodging houses 300 cubic feet. These amounts are based on the minimum requirements of a cold climate, and are probably in excess of the minimum amount necessary under the conditions existing in Bombay, where 100 cubic feet per head might be accepted as a standard.

It should be remembered that the air supplied is frequently derived from tainted sources, through windows opening into common gullies in which are situated basket privies and in which decomposing food lies and into which all the household refuse is thrown resulting in choked drains. Apart from this, in many of the gullies the air is practically stagnant owing to obstructive buildings.

In Municipal bye-laws there are very few rules for ventilation of buildings.

It is obvious that for school purposes a building requires something more than mere compliance with Municipal bye-laws, and that if proper light and ventilation are to be secured a separate standard should be set up in regard to these two necessities. The area of the windows clear of the sash panes should be from one-fourth to one-sixth of the floor space, and wherever possible the rule should be observed that lines drawn from the bottom of the wall of the school building to the tops of the nearest adjacent buildings should not make a greater angle than 30° with the horizon.

"Open air" classes are now commonly in use and should be valuable in India.

Sanitary Conveniences.

The provision of proper sanitary conveniences is an important matter, as the absence of proper accommodation leads to the formation of undesirable habits. In many of the schools, the scholars, in the absence of a urinal, regularly use the *mori* as a urinal. As already suggested, attendance at school should involve more than the absorption of the elementary principles of Algebra, Euclid, etc.,etc.: the scholar should also assimilate the knowledge of the benefits to be derived from fresh air, light and good sanitary conveniences. It is but reasonable to suppose that, if he has been accustomed to plenty of air and light at school, and has experienced the advantages of the rapid removal of excreta from the premises by the water carriage system over the old method of leaving such excreta in the immediate vicinity of the house and thereby poisoning what little air is available, he will become dissatisfied with the older insanitary methods under which the majority of the inhabitants live. Conversely, if in childhood and youth he has become accustomed to insanitary habits acquired at school, owing to absence of necessary accommodation, the incentive to elevate himself and improve his surroundings is absent. For this reason, and also on account of the prejudicial effect on his health while at school under such conditions, it is as essential as any subject in the curriculum that water closets in sufficient numbers and urinals of modern pattern should exist in all schools; otherwise the student, who at that age is particularly receptive of impressions, will probably base his standard of living on the lines apparently recognised as sufficient and proper by the school managers. The use of the *mori* as a urinal should be absolutely prohibited. In all mixed schools separate closet accommodation should be provided for the two sexes—a requirement which is not observed in certain of the existing schools.

Walls and Flooring.—The walls of the rooms should be tiled or painted so as to permit of regular washing; the colour should be a pale and subdued one, *e.g.*, greenish grey. The junction of the wall with the floor and ceiling should be rounded, so also the junction of one wall with another, in order to facilitate cleansing.

The floor should be of concrete or tiles, which should be thoroughly washed every day. In many schools the floors are of Koba and are consequently damp.

All staircases should be at least 5 feet wide with a door at the bottom opening outwards.

Desks.—The bulk of the schools in Indian cities do not contain any desks at all. The provision of desks involves a large expenditure if they are of the proper pattern ; and it is most important that they should be of the correct position and pattern, as this has an intimate bearing on the growth of less vigorous children, faulty position leading to rounded shoulders, imperfectly developed chests and spinal curvature.

Desks should be arranged parallel to one another at right angles to the windows, and wherever possible should be placed in the space intermediate between two windows. The desks should be from 16 to 18 inches broad and have a slope of about 15° for writing and 45° for reading.

The seats must be of such a height as to allow the scholars' feet to rest on the floor and be broad enough to support the greater part of the thigh. They must have a back placed at such a height as to fit the hollow of the back below the shoulder blades and support the body in a vertical position. When used in writing, the edge of the desk must overhang the edge of the seat by an inch or two in order that the scholar shall not need to stoop forward. Either the desk or seat must be movable at pleasure, so that, although the desk usually overhangs the seat, the scholar may be able at any time to stand upright in his place.

Cloak Rooms.—In India possibly this accommodation may be thought unnecessary, but a room should be provided wherein to place umbrellas and cloaks used during the monsoon period. Cloak rooms should be provided and should be capacious, well-ventilated and fitted with numbered pegs at intervals of at least 12 inches.

Water Supply.—In the majority of schools in India water appears to be stored in earthenware chatties placed in a variety of situations, most usually the *mori*, drinking-cups being used in common by the scholars. This custom may be a means of spreading infective throat troubles, unless the most careful attention is paid to the cleanliness of the cups. Moreover, means should be adopted to obviate the necessity of dipping the cup into the chatty in order to obtain water. In a school with many scholars such a custom is bound to result in more or less gross contamination of the water.

Meals.—The practice of the scholars partaking of the midday meal in the same room as they have been working all the morning should be abandoned, as the midday interval is a suitable occasion on which to open all the windows and doors so as to obtain as thorough renewal of the air in the room as possible.

Position of Schools.

It is not possible that the educational needs of a city can be met by new buildings in every instance, and consequently old buildings not specially designed as schools must continue to be used, and it is in respect of this type that a measure of reform is necessary.

Before a building is rented or leased for the purposes of a school, reference should be made to the Sanitary Engineer and the Health Officer for a certificate that the premises are suited for the purpose. In granting this certificate, or otherwise, consideration should be paid to the lighting, ventilation and provision of sanitary conveniences, and in respect of ventilation the certificate should state the maximum number of scholars permissible in each room on the lines of the Common Lodging Houses Act of England. In estimating this number, the present standard of the Bombay Schools Committee may be followed, *viz.*, 10 square feet and 90 cubic feet per head, where free and adequate ventilation is available. Intelligent co-operation on the part of the teachers is also necessary, as there are many instances of rooms in the same building in which the number of scholars in each room is in more or less inverse ratio to the respective cubic capacities of the rooms. This is merely want of supervision and co-operation ; while there would be still room for this, the system of certifying the maximum capacity of each room would serve to prevent the existing gross over-crowding.

In regard to lighting, great attention should be paid not only to the intensity of the light, but also to the source in relation to the students. The certifying officer should express an opinion as to the sufficiency thereof and also state the most suitable method of arranging the scholars ; with a view to obtaining left light if possible and of avoiding what is so frequently seen, front light. In any room it is quite as easy to conduct a class on proper lines as on wrong ones, given initiative and knowledge on the part of the teacher. Where these are non-existent, the certifying officer can supply the necessary information.

In regard to sanitary conveniences, it is of the first importance that no building should be certified until adequate provision of privy seats and urinals has been made. In mixed schools these must be separate. In connection with the use of privies, &c., much more severe discipline is necessary, and no false and hypothetical religious scruples should be held to condone misuse of such conveniences. Until the youth of a city is made not only to understand the proper method of use, but also to put such into practice, we cannot hope to derive the full measure of benefit that should follow the introduction of Western methods of removal of excreta.

MEDICAL INSPECTION OF SCHOOL CHILDREN.

Medical inspection at school concerns the State, the public health and the individual.

The State requires a physical census of the children for the discovery of unrecognised defects, partly with a view to the improvement of the national physique and partly with a view to the preparation of all children for school life. It is also a national duty to arrange for the classification of children according to their mental capacities, and to adopt the educational system to the requirements of the several groups of children, in order to diminish the present economic wastage of misdirected educational efforts.

It is the duty of the local authorities to protect the individual against communicable diseases in school, to supervise school buildings and to secure healthy surroundings for the school child.

Owing to ignorance, neglect, or apathy on the part of parents, it becomes a requirement of the merest humanity to bring medical aid and special educational methods within the reach of the individual child.

These aims and ideals can only be attained by the introduction of a system of routine inspection of the children by medical men interested not only in public health but also in education.

School hygiene may be regarded as the latest development of education in its more comprehensive aspects ; it is the initial step in a great scheme of progress, a scheme which involves the improvement of the existing conditions of mental, moral and physical development of the children. The scheme also aims at the prevention of disease in childhood, and at raising the standard of national physique. Its final goal is the development of a science of education itself. These aims are definite and practical and may be summarized under the following heads :—

(1) Routine medical inspection ;

(2) Physiology and psychology of ordinary educational methods, &c. ;

(3) Special educational methods for abnormal children of all the many different types—the mentally and physically defective, the dull and backward, the blind, deaf and the debilitated, &c. ;

(4) Scientific supervision of school methods, *i. e.*, of nursery schools, school furniture, buildings, baths, douches, ventilation, lighting, &c. ;

(5) Physical education, including supervision of manual training, gymnastic exercises, organized games, dancing, &c. ;

(6) Teaching of hygiene to teachers and others ; and lastly,

(7) Prevention of infectious diseases and attention to the sanitary condition of the premises.

The duties of medical inspection are—

1. To examine every child,about the time of its admission to an infant school, as to cleanliness and as to its obvious physical defects. The first examination should be conducted in the presence of parents and guardians.

2. To examine in detail every child about the time of its transference to the upper school,that is about seven years of age, and to decide what special educational training (if any) is suitable to the child.

3. To visit and inspect all classes once or twice a year, both as regards the general health and physique of the children and also as regards the conditions under which they

are working, namely, the ventilation, lighting, &c., on the one hand and the amount and kind of work, over-pressure, fatigue, physical exercise, manual training, &c., on the other hand.

4. To make special visits to the boys' and girls' departments once a year for the purpose of examining all children suffering from defective vision and to report upon eye disease generally. The teachers should test the vision of all children once a year, but the doctor's examination can scarcely be undertaken at the time of his visits for other work, except in very small schools.

5. To supervise the work of nurses with regard to ringworm, vermin and skin affections, and to visit each school once a week or once a fortnight for the general examination of special children selected by the teacher or nurse.

6. To advise the School Committee upon various points of hygiene bearing upon educational matters, and to give definite instructions about the care of delicate and defective children.

7. To give lectures to teachers and others upon School Hygiene and elementary Physiology.

8. To deal with the question of medical certificates of absence given by other practitioners. This duty might be combined with the weekly visit to the schools.

9. To investigate (if necessary) in conjunction with the Health Officer all epidemics and outbreaks of infectious disease in the school, and also to take measures to prevent not only the spread of the disease but also the unnecessary closure of the school.

In 1907, an Act was passed in England and came into force in January, 1908, providing for the medical examination of school-children.

Section 13 of the Education (Administrative Provisions) Act provides that "the powers and duties of a local education authority under Part III of the Education Act, 1902, shall include the duty to provide for the medical inspection of children immediately before, or at the time of, or as soon as possible after their admission to a public elementary school, and on such other occasions as the Board of Education direct, and the power to make such arrangements as may be sanctioned by the Board of Education for attending to the health and physical condition of the children educated in public elementary schools ; provided that in any exercise of powers under this section, the local education authority may encourage and assist the establishment or continuance of voluntary agencies, and associate with itself representatives of voluntary associations for the purpose."

In a memorandum on the Medical Inspection of Children in Elementary Schools (Circular 576), the Board of Education state that "the Board desire to emphasize that this new legislation aims not merely at a physical or anthropometric survey, or at a record of defects disclosed by medical inspection, but at the physical improvement, and as a natural corollary, the mental and moral improvement of coming generations." The main principle, the recognition of which the Board regard as absolutely necessary for the development of the administration on sound lines, is that "school hygiene cannot be divorced from home hygiene, and this is in turn intimately bound up with the hygienic conditions of the community. Efficiency and economy require, therefore, an organic relationship between the daily work of the school authority and of the authority responsible for the administration of the wider branches of public health. . ."

The Board add that "while it is not expected that by establishing the necessary administration on the broad basis of public health all difficulties will be avoided, the Board are convinced that this is the only practicable method and that which is most likely to promote economy, harmony and efficiency." The Board express the opinion that "in county areas the County Council, which is the local education authority, should instruct their county medical officers, who will be responsible for the smooth and effectual administration, to supervise the work, its actual execution being deputed wholly or partly to suitable medical colleagues or assistants (men or women), who either will be appointed specially for the purpose under him or will be local Medical

Officers of Health, and to whom groups of schools may be allocated. . . That is to say, generally speaking, the work of inspection should be supervised by the Medical Officer of Health of the authority which appoints the Education Committee; and when the work is obviously more than he can undertake unaided, it should be entrusted to one or more medical officers working under his supervision."

The Memorandum further discusses the character and degree of medical inspection and states that the Board have decided that not less than three inspections during the school-life of the child will be necessary to secure the results desired. The first inspection should take place at the time of, or as soon as possible after, admission to school; the second at or about the third year (say the seventh year of age); and the third at or about the sixth year of school-life (say the tenth year of age).

The Board also discuss the subject of amelioration and physical improvement, for which a scheme has to be submitted by the local education authority for the sanction of the Board of Education, and in conclusion urge "the progressive unification of the Medical Services."

The Act came into force on the 1st day of January, 1908; the directions of the Board of Education on the subject were issued as a Memorandum (Circular 576) in November, 1907.

The minimum requirements of the Board of Education were (1) a medical inspection of every child not less than three times during its school-life; (2) the registration of the facts thus recorded (the register to be kept at the school); and (3) the submission to the local education authority and the Board of Education of a detailed annual report of the work and its results.

At the same time, both the Board of Education and the Local Government Board expressly stated their view that this work was part of the general work of public health, and their desire that it "should be carried out in intimate conjunction with the public health authorities and under the direct supervision of the Medical Officer of Health;" and in Circular 576 they further affirm the principle that "as far as is practicable the School Medical Service should be unified with the Public Health Service." The advantages of such unification of the Public Health Services had already been recognized by the Inter-Departmental Committee on Medical Inspection and the Feeding of School Children; and "efficiency and economy require, therefore, an organic relationship between the daily work of the school authority and of the authority responsible for the administration of the wider branches of public health."

Organization in England:—Turning to the organization in England, we find that the respective functions of the Board of Education and the local education authorities are clearly defined by the Act. The duties thrown upon the Board consist in advising local education authorities as to the manner in which they should carry out the provisions of the Act, and in supervising the work they are called upon to undertake in giving such directions as may be necessary regarding the frequency and method of inspection in particular areas ; and in considering and sanctioning such arrangements for attending to the health and physical condition of the children as may be submitted to them by individual authorities. The Board will also collate the records and reports made by the authorities and will present an annual report to Parliament.

The duty of carrying out the annual inspection has necessarily been entrusted by Parliament to the local education authorities and not to the Board. Each authority must therefore in due course appoint such medical officers or additional medical assistance as may be required for the purpose.

In view of the varied influences which affect, directly or indirectly, the health of the children of the nation, it is manifestly of the highest importance that the administration of this Act should rest upon a broad basis of public health, and should not only secure for local education authorities as much freedom as is consistent with adequate uniformity in the presentation of results for comparative purposes, but should also use to the utmost extent the existing machinery of medical and sanitary administration, developing and supplementing it as required, rather than supplanting it by bringing into existence new agencies, partially redundant and possibly competing.

The Board view the entire subject of school hygiene, not as a speciality or as a group of specialities existing by and of themselves, but as an integral factor in the health of the nation. The application of this principle requires that the work of medical inspection should be carried out in intimate conjunction with the public health authorities and under the direct supervision of the Medical Officer of Health. The advantages of such unification of the Public Health Services have already been recognized by the Inter-Departmental Committee on Medical Inspection and the Feeding of School Children, and also by the Local Government Board, who specifically require every Medical Officer of Health to report officially upon matters relating to the sanitary condition of all schools, including the "action taken (by the Sanitary Authority) in relation to the health of the scholars and for preventing the spread of infectious disease. . . . ."

School hygiene, the Board of Education observe, cannot be divorced from home hygiene, and this in turn is intimately bound up with the hygienic conditions of the community. Efficiency and economy require, therefore, an organic relationship between the daily work of the school authority and of the authority responsible for the administration of the wider branches of public health, including the supervision of water and milk supplies, food, housing and sanitation, inquiries into matters affecting infant mortality (including ante-natal influences), home visiting by men and women inspectors, sanitary and bacteriological investigations, the provision of hospital accommodation, disinfection, the cleansing of verminous persons, the notification of the prevalence or otherwise of diseases, such as Phthisis, affecting the adult population, and the consideration of social factors, such as the occupation of the parents, or the health, habits and physical conditions of the family, all of which have a bearing, direct or indirect, upon the children's health.

Generally speaking, the work of inspection is supervised by the Medical Officer of Health or the authority which appoints the Education Committee; and when the work is obviously more than he can undertake unaided, it is entrusted to one or more medical officers working under his supervision. In some districts it is convenient for such officers to be local Medical Officers of Health holding office within the county; in others, they are registered medical practitioners specially appointed for this purpose. Provided that the principle of co-ordination of the medical services is secured in practice, and that the requisite personal and professional qualifications for the new work are present, the functions of the School Medical Officer may be exercised by a Medical Officer of Health, a Poor Law Medical Officer, a private practitioner, or, as occasion requires, a skilled specialist. There are many cases in which women are likely to be specially suitable. In making such appointments, preference is given to medical men and women who (1) have had adequate training in State Medicine or hold a Diploma in Public Health, (2) have had some definite experience of school hygiene, and (3) have enjoyed special opportunities for the study of diseases in children.

Subsidiary Agencies.—It must be distinctly understood that the work of medical inspection cannot be properly accomplished by medical men without assistance. The teacher, the school nurse (where such exists) and the parents or guardians of the child must heartily co-operate with the School Medical Officer. In whatever way the system be organized, its success will depend, immediately and ultimately, upon the cordial sympathy and assistance of the teachers.

The increased work undertaken by the State for the individual will mean that the parents have not to do less for themselves and their children, but more. It is in the home, in fact, that both the seed and fruit of public health are to be found. All-round co-operation between School Medical Officer, teacher, nurse, health visitor and parent will prove both effective and economical.

Character and Degree of Medical Inspection.

From what has been said it will be clear that the fundamental principle of the English Act is the medical examination and supervision not only of children known, or suspected, to be weakly or ailing, but of all children in the elementary schools, with a view to adapting and modifying the system of education to the needs and capacities of the child, securing the early detection of unsuspected defects, checking incipient maladies at their onset, and furnishing the facts which will guide education authorities in relation to physical and mental development during school-life.

The directions given in the Circular issued by the Board of Education as to the degree and frequency of inspection refer only to the minimum medical inspection, the effectiveness of which is to be one of the elements to be considered in determining the efficiency of each school as a grant-aided school. They are not intended to exclude other medical work, which should be undertaken by local education authorities, according to their abilities and opportunities. For example, the periodical re-testing of the eye-sight of every child; an annual measurement of height and weight; the more frequent examination of particular children, especially of those suspected to be suffering from deficient nutrition or found to be defective at former inspections; careful anthropometric surveys or special inspections at various ages of school-life; and similar investigations of a special nature, undertaken in particular districts, come within the category of additional medical work, wholly desirable where practicable, and calculated to advance school hygiene. Such work, however useful, had to be looked upon as subsidiary to the main purpose of the Act.

Regulation.—The Board of Education in England have decided under section 13 of the Act that not less than three inspections during the school-life of the child will be necessary to secure the results desired. The first inspection should take place at the time of, or as soon as possible after, admission to school; the second at or about the third year (say the seventh year of age); and the third at or about the sixth year of school-life (say, the tenth year of age). A further inspection immediately before the departure of the child into working life would be desirable where practicable, and in some areas it may be best for this to take the place of the third inspection. Certain adjustments will be necessary in working out any standard in practice, as it will at once be evident that without such adjustment the first year would be unduly burdened with the inspection of the children newly admitted and of all the children already in school.

Each authority has been directed to make provision, when the Act has been sufficiently long in operation to be in normal working, for the inspection in each year of (*a*) the children newly admitted; (*b*) the children in the school who in that year had matured for their second inspection; (*c*) those who had matured for their third inspection; and where practicable (*d*) those about to leave school. But in the first year it may prove impracticable to attempt more than the inspection of the children newly admitted and those leaving school; and in the second year it is considered sufficient if those newly admitted and those leaving are inspected, with the addition of children who have matured for their second inspection (which is perhaps the occasion of all others requiring the most thorough examination). Such adjustment tends to equalize the burden over successive years. The precise way in which the children are grouped in the school for medical inspection may vary according to the internal organization and circumstances of each school. It may be most convenient, for instance, to carry out the inspection on an age-basis rather than on a basis of period of school-life.

There are some further regulations—

(*a*) The inspection should be conducted in school hours and on school premises, and in such a way as to interfere as little as may be with school work. The examination of each child need not, as a rule, occupy more than a few minutes.

(*b*) The convenience of the teaching staff and the circumstances of each school must receive consideration, and in these matters and in the actual examination the Medical Officer will no doubt exercise sympathy and tact, giving due thought to the personal susceptibilities of those concerned.

(*c*) The facts revealed by inspection must be entered in a register kept at the school, (somewhat in the following form), the confidential nature of many of the entries being carefully respected. A copy of the entries should be transmitted with the child to any other school to which he or she may go.

Name :— School :—
Address :— Date of Birth :—
Illness previous to admission :—
Family History :—
Date :—
Standard :—

Without Shoes	Height :— Weight :—
Vision	Teacher :— Doctor :—
Hearing	Teacher :— Doctor :—

Age at Examination :— years months.
Remarks :—
Date :—
Cleanliness :—
Clothing :—
Physical Stature :—
Nutrition :—
Teeth :—
Throat and Nose :—
Eyes :—
Ears :—
Speech and Mental Capacity :—
Remarks :—

Initials of Examiner.

(*d*) Every School Medical Officer should make an annual report to the local education authority on the schools and children under his superintendence, which should be printed for facility of reference and in order that a supply of copies may be available for distribution among the members of the authority and other persons interested. The authority should send two copies of the report to the Board of Education as soon as possible after the end of the year under review.

(*e*) In order to secure effective basis for comparison of the work done in different parts of the country, one uniform year must be taken, the year to be adopted being in all cases the calendar year, in order to correspond with the annual period fixed for the closely related report of the Medical Officer of Health.

(*f*) The report should be concerned chiefly with the conditions and circumstances affecting the health of the children in the elementary schools of the district.

(*g*) It should also contain statistical records of the number of children examined and of those re-examined or under medical supervision; the nature and results of the examination; the number of visits paid to classes; the number and character of the diseased conditions found at certain age-periods; particulars as to blind, deaf, defective and epileptic children; the medical advice given both as to the prevention of conditions inimical to health and remedy of diseased conditions that may be discovered; action taken, and so forth.

(*h*) In addition to such records it will be well, as far as practicable, to make systematic comparisons of the individual and collective measurements and characteristics of the children in each school with standard and local records, both as a means of determining the condition of health of particular children or classes, for guidance in future action, and as part of the anthropometric survey to which this Act should contribute in due time. This part of the work, however, must be kept in a secondary position while so much remains to be done in the elementary essentials of school hygiene. It is to those essentials and the manner and degree in which they have been dealt with in his district, that each School

> Medical Officer should devote the major portion of his report.

Medical inspection of schools forms an integral factor in every modern system of education, and its expediency may be assumed from its successful administration in other countries.

Fundamentally, the State control of health inspection depends upon the fact that a large proportion of children attending State schools are suffering from preventible and remediable diseases. It matters not for the moment to what extent the home is responsible, nor how far the diseases are aggravated by school-life. It is sufficient that the defects are unrecognized either by teachers or parents, who alone are in contact with the children.

Hence it is clearly a national duty to discover a system by which these preventible and remediable defects may be brought to light. It is unessential to the State whether the health inspection of its children takes place in the school, at the home or elsewhere, so long as a physical census is taken and all defects are investigated, but, seeing that the children are collected together during nine or ten years of their life in State schools for the purpose of education, it becomes a matter of convenience to delegate the nation's responsibility to the Education Department.

The *a priori* argument for the State control of a system of health inspection rests upon the fact—which cannot be denied—that there are present in the schools (town and country alike) children suffering from preventible and remediable diseases, of which both the teachers and parents are ignorant; besides others, suffering from diseases the serious nature and consequences of which no one but a medical man can recognise. The assertion scarcely needs the support of figures and statistics, but it is stated in the report of the Chief Medical Officer to the Board of Education, England, that more than 80 per cent. of the children are suffering from defective teeth, that 50 per cent. are affected with vermin or other parasitic conditions, 20 per cent. with defective vision and that 10 per cent. are retarded in their educational progress by physical defects, such as anæmia, general debility and deafness resulting from adenoid growths or discharging ears ; in addition to these, in India, Malaria, enlarged spleen, Intestinal Diseases and worms, &c., will have to be considered.

As long as there are in the schools such children as those which have been described, so long the necessity for systematic health inspection is obvious from all points of view. In other words, medical inspection in the elementary schools is necessary, because the parents are ignorant. It is only a means to an end, and at present the end is the education of the people. Indeed it has been argued that it devolves upon the State at the present day to make good its defective training and education of the parents, during the last twenty or thirty years, by directing a system of health inspection towards the education of parents and children alike. For, if all parents had been taught the elements of healthy living and were able to recognize the presence and to realize the importance of physical disabilities and defects in their children, systematic health inspection would, theoretically be out of the question. Medical advisers to local education authorities would still be necessary, and little more.

But, as matters stand to-day, the interference of the State is essentially justified by the large amount of preventible and remediable defects among school-children. These defects are unrecognized either by teachers or parents, and can only be discovered by systematic medical inspection.

THE PROBLEM IN INDIA.

If the work of school medical inspection is of such value in England, it must be doubly valuable in India, as, in addition to the minor ailments and physical defects which would come under notice and about which advice would be given to the parents regarding prevention and treatment, the control of infectious diseases and Tuberculosis and Malaria would be of immense benefit to the public health conditions of the country.

In Bombay there are 239 Primary Schools—both Municipal and aided—with about 25,000 pupils ; and over 200 such unaided schools with more than 13,000 pupils.

The population of children of school-going age is about 1,12,000, thus leaving about 74,000 children who do not attend school and who could not be at present brought into this scheme.

Thus 38,000 pupils are a very considerable proportion of the City's school-age population, and the need for a measure that will help to improve the health and physical condition of such a large number of our future citizens requires no emphasis, whether from the standpoint of public health or education. The need is all the greater as the mass of poor and ignorant population is so much larger and the elementary laws of health and hygiene are so ill-understood.

It is not suggested that the Schools Committees of the various Municipalities rush at once into a large staff of Medical Inspectors, as is done in England, but gradually adopt a scheme which would lay the foundation for future development.

In England the cost of school medical inspection is about 1 shilling per head of the average school attendance. A beginning could be made in Indian towns at a cost of about annas six per head, if the work be done by the Health Department.

In England the Medical Officer of Health in all the large towns and counties is now also School Medical Inspector on increased salary and under him is the Local Health Officer as Assistant Medical Inspector.

There will be a large amount of inspection as well as clerical labour and correspondence, and this cannot be done by the staff of the Health Department without considerable assistance, as it is generally over-burdened. But the question is so intimately connected with the public health that it cannot be divorced from it, and in order that a start should be made, the Health Department of each Municipality should be asked to undertake the work on suitable terms. The alternative would be to appoint a separate medical officer who has had experience in school hygiene and two or more full-time medical officers with suitable office and staff with several Lady District Visitors and Nurses making a separate department altogether: but this would be more expensive.

How to take a Physical Census of School Children in India.

The following is an example of an experimental examination of the physical condition of the children attending 4 Schools in Bombay.

The examination was conducted by four District Registrars—qualified medical men—under the supervision of an Assistant to the Health Officer.

The work was carried out with a view of estimating the expenditure required to carry out a complete physical census of the children attending Municipal Schools in Bombay.

The work was performed at the time stated to be most convenient to the Head Masters.

Of the 313 children examined,	Per cent.
Vision was defective in	21·40
Hearing ,, ,, ,, ...	14·05
Teeth were ,, ,, ...	43·76
Throat and Nose were defective in	41·53
Glandular enlargement existed in	6·70
Head and Body uncleanly in	37·69
Clothing uncleanly in	47·92

These figures indicate that it is desirable to obtain information on a larger scale.

From the experience gained in this experiment on a small scale, it has been ascertained that on an average 10 minutes are required for the examination of each child, exclusive of time taken in recording the weight and height and in entering the name, age and address of each child; this latter information was supplied by the Head Masters; the weight and height were not recorded owing to there being no apparatus for the purpose.

In conducting a census on a large scale, these points would be attended to by the Nurse.

Assuming that there are roughly 16,000 children to be examined, one man working continuously for 8 hours per day would take about 333 days to finish all the school children.

On the average there are 78 holidays, and in addition 52 Sundays, which are also recognised as school holidays and some of which, however, will probably coincide with the various caste public holidays. Allowing, say that 10 such Sundays will occur in a year, we have 365—less 78 and less 42=245 working days. So that one man working hard for 8 hours per day could not finish the census in one year.

It is almost impossible that one man could stand the physical strain of 8 hours' continuous labour per day for such a period; and, moreover, the estimate above given makes no allowance for time taken in going from one school to another, and does provide for absolutely consecutive periods of 10 minutes for each child for 8 hours per day. This, as already stated, is practically impossible.

To do the work properly and to avoid scamping, three men working whole-time would be necessary: that is the number required if the School Committee elect to employ whole-time men. These men would probably finish the work in about 5 months.

As the work in the first instance would be of a temporary nature and as it is very desirable to obtain reliable information, it is suggested that the pay offered for such work should be fixed at Rs. 175 per month.

On the whole, it is recommended that the employment of three whole time men would probably be the more satisfactory arrangement.

From the list of schools supplied by the Committee, it appears that there are 35 Girls' Schools.

It is distinctly desirable that the examination of the height, weight, head and skin of the children in these schools should be conducted by a Nurse, and, further, that a Nurse should be present when the children are being examined for hearing, eye-sight, etc.

When not engaged in this work, the Nurses must record height and weight of the children in the Boys' Schools. Three Nurses are necessary for the purpose at a remuneration of Rs. 75 per mensem.

A considerable amount of clerical labour is involved in the scheme. The forms are filled in by the District Registrars themselves, but a summary is necessary.

Rough estimate of cost if carried out by the existing District Registrars' Staff :—

	Rs.	a.
I.—Ten Medical men, each Rs. 50 p. m. for 5 months	2,500	0
II.—Three Nurses each Rs. 75 p.m. for 5 months	1,125	0
III.—Clerks, 10 (District Registrars' Clerks), each on Rs. 5 p. m. for 5 months	250	0
One Head Office Clerk on same allowance	25	0
or		
One whole time clerk on Rs. 30 p. m. for 5 months	150	0
IV.—Weighing and height-measuring machines, two, each @ Rs. 130	260	0
Labour for moving scales from one school to another at, say, Rs. 10 per scale p.m.	50	0
V.—Eye Testing Cards— If District Registrars employed 10 of Marathi, Urdu, and English @ three-fourths the set for the three	32	8
VI.—Stationery, Printing, etc.	325	0
Total Rs.	4,567	8
Or, Rs.	4,442	8
VII.—Contingencies, travelling, &c.	450	0
	4,892	8
Say, Rs.	5,000	0

Rough estimate of cost, if work is carried out by three whole-time medical men—

	Rs.	a.
I.—Three medical men @ Rs. 175 p. m. for 5 months	2,625	0
II.—Three Nurses @ Rs. 75 p.m. for 5 months.	1,125	0
III.—One whole-time Clerk @ Rs. 30 p.m.	150	0
IV.—Weighing machines, each @ 130—two—labourers for moving the same @ Rs. 10 per scale	50	0
V.—Eye Testing Cards, 3 of each, English Marathi and Urdu @ three-fourths the set	9	12
VI.—Stationery, Printing, etc.	325	0
	4,544	12
VII.—Contingencies, travelling allowances, &c.	450	0
	4,994	12

Say, Rs. 5,000.

From the point of view of expenditure, it will be seen that there is practically no difference in expense, whether the work be carried out by the existing staff of the District Offices or by special whole-time men.

If possible, a small room or a separate *verandah* should be placed at the disposal of the medical man during the actual period of examination, in order that the work of the School should suffer a minimum of interference. Otherwise the whole work of the class may be interrupted during the period of examination, due to a lack of intelligent co-operation between the staff and the medical man which should soon disappear. It is quite unnecessary to suspend the lesson. All that is required is that the master permit 1 or 2 children to leave the class, in turn, be examined and return immediately to work.

To establish such an orderly system will be one of the Nurse's most important duties, as it is desirable not to interfere with the teaching carried on in the least practicable degree. The use of a separate room would, of course, largely conduce to this object.

Instructions for Medical Inspection of Schools.

(1) The District Registrar of......District is directed to visit the School mentioned below opposite his name and inspect the medical condition of each child in the School and record the conditions found on the accompanying form. A Nurse or Lady Health Visitor should accompany the District Registrar.

(2) At least 5 days before they visit the School they are requested to write to the Head Master of the School and ascertain the *names, ages and the dates of births* of each child (to be recorded by dates of the Christian era). This information *need not* be sent to the District Registrar but should be ready for him on his visit to the School.

(3) The District Registrar should give 24 hours' written notice, to the Head Master, of the date on which he intends visiting the School and also state the proposed time of his visit.

(4) Although it is perhaps unnecessary, it is pointed out that the District Registrar is expected to interfere with the School routine as little as possible—and to examine only one class at a time—*and in some place where the attention of the other scholars is least likely to be diverted to him and his work.* It is particularly desired that as little interruption of school labours as possible should occur, *and the District Registrar should consult the Head Master as to the order in which the various classes are to be examined and also obtain his assistance in selecting a place or room for the examination,* bearing in mind the request above mentioned. The Lady Nurse to be present when examining female children.

(5) It is necessary that this information be obtained and recorded most carefully and not in a routine desultory manner, as such would vitiate the whole value of the inspection.

(6) At the same time the District Registrar should remember that too much time must not be spent on one or more cases interesting from a medical point of view; this is not

the object in view. The District Registrars are requested to note the exact time taken by them in examining the cases, *e.g.*, started work at , finished at ; number examined.

(7) Besides the accompanying form A, there are several small forms 1, 2, 3, etc. (in all); these are *not* to be filled in, they are merely guides to the lines on which the various heads of form A have to be filled in, and the points to which special attention is to be directed.

(8) The heads—Previous History and Family History—should be filled in as briefly as possible and only points of real importance recorded. For this purpose it is suggested that before writing anything, a complete verbal history be obtained, if the scholar is old enough, and only points of importance recorded. If the scholar is too young to impart any information, then leave blank or say so.

(9) Too much time must not be spent over one; *but on the other hand the examination must be genuine* and not scamped *and the average time taken noted.*

The entries must be neatly and legibly written.

(10) If the scholars cannot all be examined on one visit, an appointment should be made for a second or subsequent visit. The actual time taken in the examination should be registered for future guidance.

(11) The entries regarding physical and mental condition should be made according to the *numerical* scale or representation laid down in the sub-forms, *e.g.*, a child of average intelligence would be entered as "4" in the proper column provided in form A.

Form A.

MEDICAL INSPECTION OF SCHOOL CHILDREN.

Name :—
Age :—
School :— Address :—
Date of Birth :—
Caste of child :—
Home address :—
Illness previous to admission, with dates :—

Family History—(only points of real importance to be mentioned.)

Date :— Standard :—

Without shoes { Height in feet:—
Weight in pounds :—

Vision :—
Hearing :—
Cleanliness of head and body (including any verminous condition) :—
Clothing—Sufficiency of ? Cleanliness of ?
Physical Stature :—
Nutrition :—
Complexion :—
Teeth :—

Examination of Teeth.

(1) Number and names of teeth missing :—
(2) ,, ,, ,, ,, ,, decayed :
(3) Any signs of oral sepsis :
(4) Any impairment of function :—

Testing of Eyes.

(1) Visual capacity.

(2) External Eye Diseases, *e.g.* {
Various forms of conjunctivitis :—
Keratitis :—
Blepharitis :—
Contagious Eye Diseases :—

(3) Internal Eye Diseases, *e.g.* {
Choroiditis :—
Iritis :—

(4) Errors of Refraction. Glasses. {
Myopia.
Hypermetropia.
Astigmatism.

(5) Squints.
(6) Remarks.

Ears and Hearing.

(1) Discharging ear ? If so, which ?
(2) Deafness present ? Probable cause ? Temporary ?

Throat and Nose.

Adenoids.—Sore throat from various causes.—Enlarged tonsils, mouth breathing (1) due to acquired habit, or (2) due to some definite obstruction in the nasal or respiratory passages, *e.g.*, polypi, chronic nasal catarrh, enlarged turbinal bones, deviated septum, etc.

Physical Condition.

It is difficult to get an exact criterion by which a standard of physical condition may be estimated, and each examiner must by experience formulate his own standard which, for purposes of record, may be expressed as a figure thus :—

Physical Stature.		*Nutrition.*		*Circulation* (as seen in the superficial mucous membranes).	
Well grown	1	Well nourished.	1	Healthy, pink	1
Average	2	Medium	2	Average	2
Stunted	3	Thin or fat and flabby tissues	3	Anæmic, sallow	3
Deformed	4	Very thin	4	Pallid	4

Thus, one may report on a child thus :—

Stature	2
Nutrition	2
Circulation	1

Speech and Mental Capacity.

Speech :—Any defect present may be due to—

(1) A peripheral cause, *e. g.*, some local defect of the teeth, palate, lips. Such defects are uncommon and are revealed during the usual examination of the mouth.

(2) Habitual defects include any type or manner of speech which the child affects, often as a result of home influence and example. In such cases the child has no impediment in speech and can be easily taught to speak correctly. In this category one may place lisping or drawling children and those neurotic spoiled children who speak in an affected manner.

(3) Developmental defects are due to imperfect development of the speech centre in the brain, whereby the child is unable to control and co-ordinate the various muscles which take part in the mechanism of speech. The condition may be diagnosed by the child's total inability to imitate particular combinations of sounds.

Mental Condition.	*Numerical representation.*
(1) Mentally defective	1
(2) Very dull	2
(3) Dull	3
(4) Average	4
(5) Quick and bright	5
(6) Very bright	6

In determining in which category the scholar should be placed, the District Registrar will perhaps consult the Head Master for his general opinion on the scholar's capacity; but, of course, his entry will be based on his own personal observation and on the history obtained.

CHAPTER XI.

HABITS AND CUSTOMS IN RELATION TO HEALTH.

The habits and customs of a people form a very large factor in relation to health and disease in every country; and although it may be considered utopian in thinking that this subject can be successfully dealt with in a work on sanitation in India, we venture to assert that, on careful investigation, some practical suggestions can be made which if not acted on immediately, will form a basis for the Sanitarian to follow in the future. We base our opinion on the hypothesis that the progress of sanitation among the masses, though slow must, by the pressure of public opinion and the ever increasing demands of education for improved surroundings, make its influence further dominant; and the object of this chapter is not so much to blame the habits and customs as to point out in what direction habits and customs, which will take much time and enormous patience to alter, do affect the health of a people.

Mention has been made how ignorant and passively resistant the ordinary Indian is to any measures, for the control of the spread of Infectious Diseases, which affect his customs and habits; and we propose to briefly explain how some features of Indian life may affect the general health of a community. Take for example, the pollution of drinking water, whether it be in a well, tank, temple, or mosque; the washing and bathing, the casting of offering and the absence of any attempt to keep the supply clean. Observe the preparation of food and sweets and the exposure for sale of articles of food; the method of collecting and distributing milk, and the conditions of domestic life; for example, it is not only the poorer class who sit on the ground and eat their food with their hand out of the same dish, but also among the better classes this custom prevails. In the streets can be seen curry and *dhal* vendors ladling out food with the hand to any passing purchaser; about schools it is common for groups of children to purchase sweets or food from itinerant vendors who mix the food stuff with their hand and serve it on a piece of paper or leaf smirched by flies, crows and dust. In the houses of most classes, the father or mother feed their children who are seated on the ground out of the same vessel, the father first taking his food, the mother afterwards. Again the proximity of animals: goats, fowls, cows, bullocks, dogs, etc., living in the same room as the tenants of houses; the amount of rubbish in houses and the facilities rats, fleas, bugs, lice, mosquitoes and flies have for propagating disease. No one with any experience of the homes of Indians in large cities, small towns or villages can fail to notice these features of common life; and to allow them to continue when they can be gradually removed is a policy which no conscientious sanitary official could accept, although he may realise the enormous task before him.

In mofussil towns and villages immediate relief cannot be hoped for, but as the inhabitants gradually emigrate to large cities they become surrounded with different conditions and it is then they learn the value of improved sanitary surroundings and systematic supervision. It will, however, take many years of strenuous endeavour on the part of the sanitary official before he can get the people to realise the necessity for observing any sanitary precautions; this is nothing new in the sanitary history of the world and it becomes the duty of the municipality to constantly impress on the people by precept and example the necessity for the observance of the laws and bye-laws relating to health. The municipalities should boldly take up this question and, while recognising the superstitious and religious objections, cope with the ignorance of the people, and gradually create a desire on their part for healthier surroundings.

With the knowledge we obtain of the ways of thought of many of the illiterate, it is easy to see how difficult it is for the people to understand why rats, flies, fleas or mosquitoes should be avoided. Constant explanation is necessary by the sanitary official of the reason why measures are taken. Every infant at school should be taught the lesson of the hygiene of every day life. All schoolmasters should have to undergo training as to the conditions affecting health.

If the religion of certain castes makes it incumbent on them to spare every living thing, it does not prevent them from taking steps to remedy filthy surroundings, and learning from their own people, who have acquired a wider insight and knowledge of the world, how to ameliorate their position. Examples of this can be seen daily in the enormous number of educated Indians taking up special branches of work in Commerce, Medicine, Law, etc., and settling down in India after having acquired experience abroad, who are rapidly dispelling many of the prejudices, habits and customs which have long proved a stumbling block to progress. The development of technical education has enabled delicate engineering, surgical and mechanical operations to be carried out by Hindu, Parsi and Mahomedan artisans. The native labourer in town has overcome his prejudice against the innovation of foreign appliances and the *mali* can be seen wheeling a wheel-barrow which formerly he proposed to carry on his head.

The enormous amount of sanitary work carried out by the municipalities of larger towns and the interest the members of the corporations take in sanitary measures mean progress.

In previous chapters, practical suggestions have been attempted and it is only necessary to briefly summarise a few points, which should be borne in mind by the sanitary official when dealing with the habits and customs of the people.

Water-supply.—Objection is taken by some to drink any water unless it comes from a well. The water, however, liable to be polluted by its surroundings, is preferred by some to tap water, and a pump cannot be fixed as it is opposed to religious prejudice. The water from the well is drawn up in all sorts of vessels which may have been used for other purposes. The washing of clothes and utensils and animals and bodies of persons takes place at the well or tank side and the well or tank is a breeding place for mosquitoes.

The danger of this proceeding is palpable to any one. The water is examined and proved unfit for use. But to persuade the people that this is so is another matter. The remedy lies in constant supervision, the provision of a wholesome supply, the protection of the wells, and the adoption of a pump instead of open domestic vessels. Such pumps are now in common use in Bombay where people prefer well water.

Milk.—To the majority of the people pure milk is unknown. The method of keeping cows and buffaloes, the manner of milking and cleaning the vessels and the accepted adulteration with unwholesome water are of such common occurrence as to be a habit.

Proper regulations of dairies and cow-sheds, constant inspection and control, and the provision of Municipal Milk Depôts will gradually induce the people to realise the advantages of cleanliness.

Food-supply.—The preparation of food stuffs and their exposure for sale are still of the most primitive order even in large cities. Bye-laws for the control of eating-houses, bake-houses, soda-water factories which insist on proper sanitary measures and protection from flies will gradually bring about great improvement.

Over-crowding: ventilation.—The high rents in large cities and the paucity of suitable accommodation for the poorer classes tend to over-crowding, which brings in its train sickness and distress. The custom of joint family life to a great extent is to blame for much of this, while the *purdâh* system increases the evil.

The laws and bye-laws governing this subject are very difficult of application. The inspection of houses liable to be over-crowded if done in the day time reveals little and there is no power to inspect at night. It can, however, always be ascertained whether a room is over-crowded or not, and if the law is set in motion temporary improvement can be made, but a remedy can only be found in extending action on the part of the municipality or local authority by providing suitable accommodation for the poorer classes, reference to which has been made in a chapter on the housing of the people.

Mention may be made of the manner of disposal of the dead, nursing of the sick, isolation of the infected ; early marriages and a high birth-rate, prostitution, sexual indulgence and venereal disease, drugs, intemperence, infant mortality, child-birth, many of which are dealt with under different headings and should be taken up by the sanitary authorities.

India is peopled by diverse races, each having its own social and religious customs and domestic habits which have been ingrained in the course of ages, so as to be innate and form a part of the integral whole, whether of the individual or the community to which he belongs.

The customs and habits of the indigenous people, whether in villages, provincial towns or presidency cities, vary according to the community. Wherever members of particular communities go, they faithfully adhere to and persevere in the customs and habits which from infancy they have acquired and practised. For purposes of description, it would perhaps be most instructive to discuss the usages, habits and customs as they obtain among communities of different religions in a presidency city. The better classes will be treated first, and a special reference will be made to the customs and habits of the labouring and depressed classes.

The City of Bombay is a large commercial emporium and sea-port of the East ; it has the fame of being cosmopolitan. Khurds and Tartars from Central Asia travelled to it in earlier days and settled therein ; also Mahomedans, chiefly of the Sunni sect, from the plateaux beyond the north-eastern frontier and Persians of the Mahomedan Shia sect ; Arabs from the Arabian Peninsula and the enterprising commercial community, the Parsis ; Hindus of all denominations and castes from the various parts of the vast continent of India have settled here. Hindus comprise nearly three-fourths of its population and Mahomedans more than one-eighth. The great aim of the Mahomedan religion in making proselytes in India was to destroy in those converted the castes of Hindus with their customs, usages and habits. In this they only partially succeeded. In Gujerat large districts were converted both by Shias and Sunnis. The two great Mahomedan commercial communities in Bombay, who hailed from Gujerat, are the Halais and Kutchi Memons and Khojas, the former being Sunnis and the latter Shiahs.

MAHOMEDANS.

Localities were selected by individual affluent and influential Memons and Khojas, whereto flocked others of the same classes converting the localities thus occupied, now known as *mohollas*. In families the Mahomedan religion was to a considerable extent successful in destroying caste prejudices, while retaining (to determine disputes and suits) the Hindu Law and introducing a new element known as the *purdâh* system, as also new religious rites with respect to customs at marriages, births and deaths. The Arabs, who were the first to arrive in Bombay from the West with commerce, intermarried amongst the aborigines of the Island, the progeny being *Natiahs*, from whom descended the great Kokni Mahomedan community, now chiefly occupying the central portion of the City. These, on account of their constant intercourse with Hindus, acquired many of their customs and habits. In justice to this community, it must be acknowledged that many acquired Western education and refinement and became highly respected leaders of society; while Memons, being essentially commercial until only recently, stuck to trade. The Khojas, the greater number of whom belong to the Shia sect, being a very pushing and enterprising community, availed themselves rapidly of Western education, adopting Western habits. The *purdâh* system amongst them now exists only in name.

It is Khojas alone who, during the early years of Plague, availed themselves of isolation hospitals and inoculation. The Borahs, another Shia community, coming mostly from Surat and Ahmedabad districts, also availed themselves to a degree of isolation hospitals, but not of inoculation. With these exceptions, the Moslem communities have a repugnance to removing their sick, in case of Plague or other infectious diseases, to isolation hospitals, etc. Even when different isolation hospitals were provided in different *mohollas* for them, the people were averse to the same, and to some hospitals not even a single case was brought.

The Kokni and Deccani Mahomedans show a great dislike to hospitals, and never to any appreciable extent took advantage of the same; perhaps this may be due to the want of religious or social heads in these communities, the result being that they suffered severely owing to concealment of cases. With the exception of the Khoja community, none of the Mahomedan communities have sought the immunity conferred by inoculation. How far inoculation has been successful in this community is proved by their relative immunity from Plague. Mahomedans as a community prefer their sick to be treated at home and nursed by their relatives, whether suffering from infectious disease or otherwise. Although the services of qualified medical men are to a great extent now availed of, yet their instructions with reference to infective material are passively resisted and ignored. This is so not only with reference to Plague but also other highly infectious diseases such as Cholera, Small-pox, Measles, etc. The infective material is not destroyed, but disposed of anywhere, preferably into house gullies. No particular care is taken by the relatives who nurse the sick, in spite of the instructions of the medical attendant, and no attempt at personal disinfection made; hence, infection is apt to be rapidly conveyed to the attendants or other members of the house. The backward classes in these communities have recourse largely to *hakims* for treatment. The *hakims* have scarcely any knowledge of personal or public hygiene. Vaccination, being compulsory, is availed of amongst Mahomedans and the children are vaccinated, some of them at a very late date. Revaccination amongst them is practically unknown. When Small-pox cases occur in houses, they are carefully concealed, lest the Health authorities coming to know of them should remove them to the isolation hospital, as required under Section 424 of the City of Bombay Municipal Act. The concealment is however never complete, as there is a superstitious belief among all the uneducated classes that *neem* (*Melia Azedirecta*) leaves hung up at the entrance of the room prevent the spread of the disease and have also a beneficial effect on the patient. The custom of hanging the twigs of *Melia Azedirecta* (*neem*) is very ancient. May this have not been intended as a danger signal for intending visitors ?

The patient is generally placed on a mat on the floor, rarely on a low cot. The bed clothes are aired in the passages or over the small fireplace. On the 7th day, after the first appearance of the eruption, a bath of a decoction of *neem* leaves is given to the patient in the *nahani* or *mori* of the room, and the body is dried with a soft towel or cloth. With those who can afford it, this towel or cloth finds its way in the house gully, whilst among the poor the same is used after being merely washed.

During convalescence the scabs are allowed to fall about the house or room, and are swept to the passage or on to stairs once or twice a day. One can therefore imagine how rapidly Small-pox spreads amongst the unprotected in a *chawl* and in its immediate neighbourhood.

The customs and usages relating to their dead will be briefly described here.

The Borahs, (Shia sect), in this respect have taken the lead ; their dead are immediately removed to the *musjid* mortuary, where the ablutions and other rites are performed before the final disposal of the remains in the cemetery. All the rest of the Mahomedan communities wash their dead in their houses on low wooden flats or benches provided by the *musjid* authorities. No disinfection is allowed in rooms or houses occupied by the diseased for three days and until the end of the *ziarath* ceremony, the family, in the meanwhile, occupying the room where the deceased suffered, receiving mourners and guests therein. The backward classes amongst the Mahomedans have a great aversion to disinfection and other sanitary methods.

They have a special dislike to sterilizers, and in most cases conceal the infected bedding and mattresses, which are either washed at home or sold, or otherwise disposed of. They believe in *kismat*, *i.e.*, fate.

The advent of Mahomedans in India amongst Hindus has been iconoclastic in tendency and has led to domestic usages in direct opposition to those of Hindus. Beef was made the staple food of the classes. Mahomedans, as a rule, indulge in mixed diet, while a large proportion of Hindus are vegetarians. The Mahomedan prefers to eat his food in eating-houses or restaurants. The hygienic condition of these eating-houses is very bad. The floors are filthy; the tables and benches are unclean and practically no store-room exists for prepared food stuffs, these being placed underneath a stair or even in close proximity to a privy, water-closet, a *mori* or washing place. Generally, food stuffs are kept in open trays without any cover to protect them from flies; if covered, it is generally with a dirty sodden cloth. Contamination, therefore, of these food stuffs is frequent and almost certain. These eating-houses are licensed by the Police, and the Municipality has only a partial control over them. On festive and mourning occasions, dinners are prepared in large cauldrons, which perhaps for years have not been tinned, and served to friends and members of respective *Jamats*. During dinners, one drinking utensil is common to a party, and dinners are served in streets or ground, bare or partially covered by mats: if sufficient accommodation cannot be found in houses. Only lately a few of the *Jamats* have opened large houses called *baughs* for such occasions, but only the rich avail themselves of these. It is nothing unusual to notice milk and curds exposed in open utensils next to a privy, or on the sill of a window opening into a neighbouring house gully. Further, water for drinking purposes is perhaps never boiled and is stored in *ghurras* (mud pots) and copper pots, on the wall of the *mori* or *nahani*. One possible cause of the introduction of Cholera into Bombay is water brought by pilgrims from the sacred wells of Mecca, in bottles and tin cans. This water is frequently mixed with a larger quantity of Bombay water and doled out to friends and relatives.

In the houses of the backward classes, a *mori* is provided in every room, and serves as a urinal at all times and as a water-closet during illness. The backward classes on account of certain habits they have, and which they will not correct, misuse water-closets and hence prefer basket privies.

HINDUS.

Three-fourths of the population of India are Hindus. These are divided into several castes, chief of which are Brahmins, Kshatrias, Vaishias and Shudras. The last include all low-castes. The Brahmins are the priestly caste, highly educated, ministering the religious rites of all the other castes. They are essentially vegetarians. The only animal food they partake is milk. For descriptive purposes all of these castes may be divided into two great divisions :—(1) those strictly vegetarians, who include milk in their diet and (2) those who partake of mixed diet. To the former belong the Brahmins, Bhattias, Jains, Shravak Banias, Marwadis and Lohanas; and to the latter, Shenvis, Prabhus, Pánchkalsis and Maráthás in general and the last, all the Shudras, who eat indiscriminately everything and partake of meal-leavings from all houses.

Until recently the floors of houses occupied by Hindus of all denominations in this City were of earth, as even now in almost all mofussil houses. A recent Municipal regulation enforces that floors should be of koba, cement and chunam. The practice that obtains in mud-floor houses is to smear them with a mixture of cowdung, red earth and water which gives not an unpleasant coating to the floor. Disinfection with chemical solutions, even the most potent, is for obvious reasons impossible: the disinfectant fluid unless used in enormous quantities becoming inert. Such house-floors are very suitable places for the breeding of fleas. Cowdung may also be the medium or vehicle of diseases, such as Diarrhœa, Typhoid, Tubercle, etc. Animals suffering from specific diseases may also by this means convey diseases to man. Mud floors being soft allow rats to make rat-warrens underneath. Experience has taught that such floors should not be allowed, and hence the Municipal regulation of koba floors. The practice of smearing floors has nearly become a confirmed habit in the people inasmuch as even to this day smearing is resorted to in kitchen and dining rooms on koba floors. It is to be noted that almost all Hindus squat and lie on floors.

Some castes of Hindus generally hold their caste dinners in *Mahajan Wadis,* specially built for this purpose. The dinners may be festive or mourning. Ladies are served first; gentlemen after; no plates are used; the meals are doled out on plantain leaves or, when these are not available, on circular *patravalies* made of dried leaves of the *Butea frondosa.* Each guest has to provide himself or herself with a small *lota* for drinking water. The water used is well water or water stored in huge underground tanks. This water is liable to contamination with droppings of birds from above, or with the washings of hands and feet of the guests before they partake of the meals.

In the first years of Plague, the people protested violently against disinfection, but experience has proved to them the benefits of disinfection and now without demur they accept it or call for it. The destruction of animal life is repugnant to all Hindus, especially to vegetarian classes, *i.e.,* Brahmins, Banias, Jains, Bhatias, etc. Even vegetarians are enjoined by certain rules to partake only vegetables of a particular kind: thus it is strictly forbidden for Jains to eat any succulent roots, tubers or bulbs, potatoes, carrots and onions, while they are permitted to eat the vegetable stalks and leaves emanating from such tubers. The meal hours are always during sun-light. The object of not eating a meal after sunset is to prevent ingestion at lamp-light of animalcules by mishap. Amongst the Bhatias there is a large number of individuals who are known as *Murjadis. Murjadi* implies the attainment of a higher degree of religious merit after a pilgrimage to the shrine of Gocul. The *Murjadis* will not use shoe-leather or drink water from a service pipe. They are strictly enjoined to drink water from wells alone. A vast number of houses is occupied by such *Murjadis*, and although warned not to drink water from wells declared by the Municipal Analyst as not fit for potable purposes, they will indulge in the same and ignore such warnings. There is no alternative therefore for the Municipality but to fill up such wells or pump them dry. During illness, they seek the advice of medical men, but will take nothing but powders.

During the epidemics of Plague the Shravak Banias, Bhatias and Lohanas suffered severely. These people are all traders and mostly reside in Mandvi on upper floors, the ground floor being used as a store-room, or godown for rice, sugar and other wares of this kind. These store-rooms are of necessity infested by rats. The religious repugnance of the inhabitants to kill or even to remove the rats after they have sickened and died leads to the infection of houses, and residents of upper floors succumb to the poison. Among Hindu traders, the Jains and Shravaks suffer most. According to the returns, the proportion of deaths amongst them is remarkable, being double that among low-caste Hindus. Isolation hospitals in the earlier years of Plague were held in repugnance by these people as by Mahomedans, and for same or similar reasons. But when private isolation hospitals were established, they took advantage of them very largely. Inoculation is objected to by them on the ground of the animal origin of the vaccine; on the other hand, though the vaccination vaccine is also of animal origin, they readily take it, as it comes from a cow or calf, which is held in special reverence and veneration. In cases of infectious diseases, no special opposition is met with in regard to disinfection. Speaking of infectious diseases, Small-pox is venerated in houses as the visitation of a deity, people refusing to remove such cases to hospitals voluntarily. This is a fruitful source of infection to the unprotected and the neighbourhood. On the 11th day of the disease, when the pustules are scabbing, a patient is conveyed, generally in a public conveyance, to certain temples where the goddess "Shitala Devi" is propitiated by offerings, &c. This is another source of public infection. The Health

Department authorities are constantly obliged to proceed against such offenders and get them fined by Magistrates. The middle classes occupy single or double rooms according to their means in tenement houses, the *mori* in these rooms being used for all purposes.

The females amongst Hindus during menstrual and lying-in periods are considered as defiles and untouchable. They are set apart in rooms and have no social intercourse and during lying-in period are attended by ignorant *dáis* or midwives. For this reason municipalities should provide trained midwives whose duties should be to be helpful during the lying-in period, to advise mothers on infant feeding and to act as Sanitary Inspectresses generally.

When a high-class Hindu is on the point of death, he is laid on a country blanket (*ghongdy*), white or black as may be available at the time in the house, and a basil leaf and some holy water are put in his mouth. If a son is present, he takes the dying head on his lap and, when all is over, the women sit round the body weeping and wailing ; the nearest female relatives affectionately caress the dead face with their hands and often use the free end of the *sádis* to wipe the face. The body is next washed near the steps of the house, dressed in white *dhoti* and transferred to the bier and conveyed to the *ghat* for cremation. The blanket and bed cloth are given to the poor.

The lower castes after the ablution anoint the dead body with turmeric and butter, while females with the free end of their *sádis* whisk the face, frequently wiping it. The body is dressed up gorgeously and conveyed on the bier for cremation. All infants and persons dying from Small-pox are usually buried. The whole of the above description applies, *mutatis mutandis*, in a lesser degree to the mixed diet classes. Because of *purdahnashin* system, notification of disease is accepted with great reluctance, if at all. Notification of infectious diseases has been more successful during the last decade than in previous years, but the fear and abhorrence of official interference still prevail, with the result that there is much concealment of cases. The wealthier classes of Hindus avail themselves of qualified medical treatment, the poorer classes being unable to do so; municipalities should establish free dispensaries for medical relief. In Bombay these are largely availed of by the poorer Hindus and Mahomedans. All sorts of ailments, infectious or otherwise, are treated, the Medical Officer, if necessary, attending the patients at their homes. The establishment of these dispensaries will lead to the better registration of births and deaths and sickness.

PARSIS.

Parsis, who in the earlier Plague years were averse to notification of Plague cases and the use of isolation hospitals, have since the establishment of Parsi Fever Hospital by their *Punchayat* behaved in a most exemplary manner in these respects. Disinfection of rooms, where deaths occur, is readily consented to after the funeral ceremonies are over. Their funeral rites are interesting. When a person dies, after due ablutions, the body is conveyed to the ground-floor and handed over to two or four of *Khandias* or corpse-bearers. The corpse is then dressed by them and placed apart in a ground-floor room on the stone slabs, where no one is allowed to approach or touch the body. In the interval before the removal of the body to the Tower of Silence, which invariably takes place in the morning between 8 and 9 and in the afternoon between 3 and 4, a priest (*Andheroo*) continuously chants prayers before the body. Before the corpse's final removal from the house, a ceremony called the *Gaihe Sarna* is performed, which consists in the chanting of special prayers by a couple of priests who stand on the doorway. These prayers are made in two parts. During the first part, the body continues to lie on the slab. This over, a dog is brought in and the dead body is exposed to its gaze a few minutes. The corpse is then transferred to a bier by *Nassesalas*, special corpse-bearers, who alone can consign the body to the Tower of Silence,—the *Khandias* carrying the body from the house to the Tower. The second part of the ceremony is now gone through and completed when the mourners all approach the room, where the corpse is, to have a last look at it. Further ceremonies are performed for a period of four days on the ground-floor, the place in the meanwhile being inaccessible to disinfection. The leaders of the Parsi community, being well-educated have set an example to other communities with reference to inoculation ; but the middle and poor classes of Parsis do not take to inoculation to any considerable degree.

NATIVE CHRISTIANS.

The Native Christians of Bombay consist of mixed descendants of Old Portuguese settlers of Bombay, Goanese Catholics immigrating into Bombay for trade and other means of livelihood, and the converts from the poorer classes of Hindus and Mahomedans by Protestant and Catholic Missions. The community, as a whole, is not wealthy, and, although in the beginning was reluctant to isolation hospitals, has shown courage and devotion in sending their sick to public hospitals. All arrangements for segregation and disinfection are submitted to without opposition or murmur. They also very largely avail themselves of free dispensaries and of inoculation. Most of the poorer classes hailing from the northern districts of Goa are unprotected against Small-pox and whenever Small-pox breaks out, this community suffers severely.

LABOURING CLASSES.

The most important of the labouring classes who come to Bombay are the Maratha Hindus. In the districts they are chiefly cultivators and agriculturists. They come from the Konkan and Deccan—also calleds *Ghattis* from the *Ghauts.* The latter are tall, sturdy and of strong physique, the former smaller and weaker. They supply domestic servants, coolies, mill-hands, weight carriers in grain godowns, in the docks and the cotton green, and some are engaged in petty business, as fruiterers, vegetable dealers, grocers, cart drivers and masons. They live in *chawls* generally in single tenement rooms, but those who can afford in double tenement rooms. Many Marathas do not bring their wives or families with them. They then club together and board and lodge in a *khanauli.* A Maratha woman keeps house and board for them on payment of a fixed sum by each member, ranging from Rs. 7 to 10. The room in which they board is small and insufficient and the boarders generally sleep in passages and *verandahs* of *chawls* or in public streets. When an illness occurs, one of the men looks after the patient and nurses him; they are averse to hospitals. It can easily be understood how in an infectious disease case, say Cholera, almost all the inmates of the rooms are attacked. During illness, as they cannot afford milk, they must perforce live on their usual food. In case of Small-pox, too, they usually conceal the case. Compared to the Mahars, etc., these people are of cleaner habits, both personal and domestic, and not indolent or lazy, and without thieving propensities. From experience during the last decade, it has been found that the Marathas have considerably improved in their personal and domestic habits. They have appreciated the supervision and hygienic conversations organised for them by the Health Department and the Bombay Sanitary Association, and one notices to-day with satisfaction the considerable improvements they have made in their personal habits and in their rooms. It may casually be mentioned here that housing accommodation for this ever-increasing labour class is quite inadequate.

Mahomedans of Konkan and Deccan and Kathiawar flock to this City, attracted by the higher wages paid for labour. The Konkani Mahomedans work as domestic servants, office *puttavallas*, boatmen, lascars, policemen: the Deccanis aspire higher and take to trades and industries; they, as a rule, earn more than their Konkani brethren, and are of cleaner habits. This great Mahomedan labouring class lives in the same manner as the Marathas and under identical unhygienic conditions.

"DEPRESSED" CLASSES.

The "depressed" classes consisting of Mahars, Mangs, Bhungis, Chambars and Dhers, whether living in towns or villages, must of necessity live apart, as they are condemned by all Hindus as "untouchables." No other community will live in close proximity to them, because of their habits, thieving propensities and immoral proclivities. In villages they live out, all huddled together in small, dark mud-huts. In towns, they live in *chawls* set apart for these people, or in the open in huts made of wattle and daub and roofing of old kerosine oil tin-sheetings. Their personal habits are very filthy, and they seem to flourish in squalor. Mahars from times immemorial have been considered essentially hereditary "village servants": their duties being the removal of dead cattle or other animals, burial of outcastes and removal of offal. They engage also in other occupations, such as rope and basket-making, etc. On account of the higher wages they can obtain for labour, they are attracted in large numbers to presidency cities. Here they are employed as dock labourers, coal fillers, and as scavengers by municipalities for the removal of street and domestic refuse. Many of them also learn different trades and "the village servant of yesterday may be seen driving a motor-car for his private master to-day, amidst the plaudits of the social reformers and the groans of the conservative Brahmins, who still consider that a Mahar's duty is to be an efficient Mahar and wait for his reward in the future stage of existence"!

The individual cost of living is very small indeed. Nothing is prohibited them by caste or religion; anything and everything is welcome from dead meat to the leavings of eating houses, *Mahajan Wadis* and hotels; they live generally in ground-floor chawls in single tenement rooms, dark, ill-ventilated, damp and overcrowded. The females especially of the Dhers and Bhungis, if not engaged as halalkhores, take to rag and bone-picking. Rag-picking is a great trade with them: to obtain rags they will steal them even from dust bins; they also purchase from servants the bed clothes and clothing of dead persons. These articles may or may not be from persons who may have suffered from infectious diseases. All these classes bury their dead. The corpse is washed in front of the hut with tepid water and anointed with a mixture of turmeric and ghee; while this is being done, the female relatives wail and caress the face of the deceased, whether the death be from infectious disease or not. The body is then conveyed on a bamboo bier to the burial ground. If death was caused by an infectious disease, the clothes, if the Municipal authorities are aware of the cause, are disinfected and sterilized. But in most instances, such cases rarely come to the notice of the Health Department, and the clothes are then simply washed and used again.

Mahars and Mangs are found throughout the Maratha speaking parts of the Deccan and the Karnatak. They appear to be, from their customs and the impurity attached to them, the broken residue of the aboriginal tribes owning the country of which they were dispossessed by successive waves of Ayran and *post*-Aryan invaders. They are regarded by all other castes of standing as "untouchables." They eat sheep, goats, dead cattle, pigs, etc., and drink liquor and live on land set apart for them outside a village. Dheds are found all over Gujerat, Kathiawar and Cutch.

Not unlike the Mahars, they seem to be the remnants of the primitive aboriginal tribes. They eat flesh, fish and also the carcasses of cows, buffaloes, sheep and goats. They eat the leavings of other people and drink liquor. Originally the occupation of Dheds was of spinning cotton into thread and weaving cotton cloth, but now they flock to presidency cities and take up the work of the bhangis of halalkhores proper.

Bhangis or halalkhores are found all over India. They are a caste of scavengers and sweepers and are the dregs of Indian society. In Gujerat they are held to be lower and more unclean than Dhers, while in the Deccan they hold the same position as Mahars and Mangs. Both the sexes are employed as night-soil carriers. The Bhangis eat carrion, flesh of cow, buffalo, goat and sheep and eat the leavings of other castes and drink liquor.

Dhers and Chambars : the former deal in cattle skins and are tanners ; the latter work in leather and are the suppliers of the foot-wear of the higher classes. These do not eat carrion but flesh of goat, sheep, pork, fish, etc. They are a degree higher than those previously described. All these classes indulge largely in country liquor.

CHAPTER XII.

HOUSING OF THE WORKING CLASSES IN LARGE CITIES IN INDIA.

During the past few years the problem of housing and town-planning has developed enormously in England, owing to the passing of the Housing and Town Planning Act, 1909, which deals with (*a*) the extension of existing towns; and (*b*) the improvement and opening up of existing insanitary areas in old towns.

In India, at present, the provisions of Acts and Bye-laws for the improvement of towns, old or new, are weak and ill-defined. The Municipal Acts and Bye-laws are so inconsistent and cumbrous as to render the work of improvement of insanitary areas extremely difficult.

The creation of Improvement Trusts in several cities in India has to some extent paved the way for a more serious and enlightened policy, but up-to-now the work of Improvement Trusts has been tentative.

No attempt at town-planning in the real sense of the word has been undertaken in India, and, with the exception of the initial efforts of the City of Bombay Improvement Trust, very little has been done in the absence of town-planning schemes to get at the bottom of the real evil, namely, the housing of the working classes and improvement of insanitary areas, because there is no financial return. Much, however, has been done in the widening of streets, and Bombay of to-day is a vastly different place to what it was in 1898.

But if real progress is to be made in the direction of town-planning in cities in India, what is wanted is an Act and Bye-laws on the line of the Housing and Town Planning Act of England, 1909, and a local authority to carry them out under a governing body.

Part I of this Act deals with the housing of the working classes; Part II deals with town-planning.

Extracts from the laws obtaining in England on this subject, taken from the Municipal Year Book, are given below :—

Extracts.

Housing legislation in England began with Lord Shaftesbury's two Acts passed in 1851, and was continued with Torren's Acts, 1866 and 1868, and Cross's Acts, 1875, 1879 and 1882, and by various Local Improvement Acts. The Metropolitan Board Works spent £1,325,415 on 16 schemes and sold or let the sites at nominal prices to various companies for building working class dwellings to house the persons displaced. The companies thus subsidised erected 7,026 dwellings, containing 14,093 rooms.

Other districts cleared unhealthy areas at a cost as follows, after recoupment for land re-sold :—Birmingham, 95 acres, for £550,000 ; Glasgow, 88 acres, for £600,000 ; Liverpool, £500,000, Greenock, £200,000, and Wolverhampton, £267,862 ; while the annual charge on the rates at Swansea has been over £3,000. In the majority of these cases some of the persons displaced were re-housed in dwellings erected by the municipal authorities. Owing to the expensive working of these Acts, however, they were not used much after 1882, and it became necessary to consolidate and amend them by the Housing of the Working Classes Act, 1890. This Act has itself been modified by subsequent Acts, notably the Acts of 1900 and 1903, and the Housing and Town Planning Act, 1909.

Powers of local authorities with respect to the housing of the working classes may be said to be contained in—

(1) The Public Health Act, 1875 (Sanitary clauses), together with the amending or corresponding measures, the Public Health (Amendment) Acts, 1890 and 1907, the Public Health (London) Act, 1891, and the Public Health (Scotland) Act, 1897, and Bye-laws made under the provisions of the same ;

(2) The Housing of the Working Classes Act, 1890, with Amending Acts of 1893, 1894, 1896, 1900, 1903 and 1909 ;

(3) The Small Dwellings Acquisition Act, 1899;

(4) The Municipal Corporation Act, 1882 (Section III), and the Working Classes Dwellings Act, 1890;

(5) The Labourers' (Ireland) Acts, 1885-1906;

(6) The Standing Orders of Parliament for Local Improvement and Public Companies' Bills.

So far as the provision of houses is concerned, the most important of these are the Housing of the Working Classes Acts, 1890, 1903, and the Housing and Town Planning Act 1909.

The principal Act (1890) is divided into seven parts, and the following summary of housing powers has been arranged under the three most important of these divisions, *viz.*, Part I, the clearance of large slum areas; Part II, the clearance of small slum areas and the closing and demolition of unhealthy houses or obstructive buildings; and Part III, which deals with the provision of new dwellings by or through the action of local authorities.

The amending Act of 1900 modified Part III of the principal Act by empowering Councils to buy land outside their districts (section 1) and to lease any land bought within or outside their districts to persons willing to build cottages (section 5), as well as for the building of cottages by the local authority. It also provided for the raising of money for Part III, schemes by metropolitan boroughs (section 3), and for simplifying accounts kept under the various parts of the principal Act (section 4). Other provisions were also made, but have since been repealed.

The Housing and Town Planning Act, 1909, modifies a number of provisions in previous Acts, as respects the keeping of houses in repair (sections 14 and 15), the closing and demolition of unhealthy dwellings (sections 17 and 18), the clearance of slum areas (sections 23-29), the appointment of County Medical Officers of Health (sections 67 and 68), and the provision of new dwellings for the working classes. It requires County Councils to establish Public Health and Housing Committees (section 71), and it gives them a number of default powers as regards District Councils and the principal Act (sections 10 and 12), while also giving concurrent powers, under Part III, in rural districts (section 13).

Duty of local authority as to closing of dwelling houses unfit for human habitation.

(1) It should be the duty of every local authority within the meaning of Part II of the principal Act to cause to be made from time to time inspection of their district, with a view to ascertain whether any dwelling-house therein is in a state so dangerous or injurious to health as to be unfit for human habitation, and for that purpose it shall be the duty of the local authority and every officer of the local authority to comply with such regulations and to keep such records as may be prescribed by the Board.

(2) If on the representation of the Medical Officer of Health, or of any other officer of the authority, or other information given, any dwelling-house appears to them to be in such a state, it shall be their duty to make an order prohibiting the use of the dwelling-house for human habitation (in this Act referred to as a closing order) until in the judgment of the local authority the dwelling-house is rendered fit for that purpose.

(3) Notice of a closing order shall be forthwith served on every owner of the dwelling-house in respect of which it is made, and any owner aggrieved by the order may appeal to the Local Government Board by giving notice of appeal to the Board within fourteen days after the order is served upon him.

(4) Where a closing order has become operative, the local authority shall serve notice of the order on every occupying tenant of the dwelling-house in respect of which the order is made, and within such period as is specified in the notice, not being less than fourteen days after the service of the notice, the order shall be obeyed by him, and he and his family shall cease to inhabit the dwelling-house, and in default he shall be liable on summary conviction to be ordered to quit the dwelling-house within such time as may be specified in the order.

(5) Unless the dwelling-house has been made unfit for habitation by the wilful act or default of the tenant or of any person for whom as between himself and the owner or landlord he is responsible, the local authority may make to every such tenant such reasonable allowance on account of his expense in removing as may be determined by the local authority with the consent of the owner of the dwelling-house, or if the owner of the dwelling-house fails to consent to the sum determined by the local authority, as may be fixed by a court of summary jurisdiction, and the amount of the said allowance shall be recoverable by the local authority from the owner of the dwelling-house as a civil debt in manner provided by the Summary Jurisdiction Acts.

(6) The local authority shall determine any closing order made by them, if they are satisfied that the dwelling-house in respect of which the order has been made has been rendered fit for human habitation.

If, on the application of any owner of a dwelling-house, the local authority refuse to determine a closing order, the owner may appeal to the Local Government Board by giving notice of appeal to the Board within fourteen days after the application is refused.

(7) A room habitually used as a sleeping place, the surface of the floor of which is more than three feet below the surface of the part of the street adjoining or nearest to the room, shall for the purposes of this section be deemed to be a dwelling-house so dangerous or injurious to health as to be unfit for human habitation, if the room either—

(*a*) is not on average at least seven feet in height from the floor to ceiling; or

(*b*) does not comply with such regulations as the local authority with the consent of the Local Government Board may prescribe for securing the proper ventilation and lighting of such rooms, and the protection thereof against dampness, effluvia, or exhalation: provided that, if the local authority, after being required to do so by the Local Government Board, fail to make such regulations, or such regulations as the Board approve, the Board may themselves make them, and the regulations so made shall have effect as if they had been made by the local authority with the consent of the Board :

Provided that a closing order made in respect of a room to which this sub-section applies shall not prevent the room being used for purposes other than those of a sleeping place, and that if the occupier of the room, after notice of an order has been served upon him, fails to comply with the order, an order to comply therewith may, on summary conviction, be made against him.

Order for demolition.—(1) Where a closing order in respect of any dwelling-house has remained operative for a period of three months, the local authority shall take into consideration the question of the demolition of the dwelling-house, and shall give every owner of the dwelling-house notice of the time (being some time not less than one month after the service of the notice) and place at which the question will be considered, and any owner of the dwelling-house shall be entitled to be heard when the question is so taken into consideration.

(2) If upon any such consideration the local authority are of opinion that the dwelling-house has not been rendered fit for human habitation, and that the necessary steps are not being taken with all due diligence to render it so fit, or that the continuance of any building being or being part of the dwelling-house is a nuisance or dangerous or injurious to the health of the public or of the inhabitants of the neighbouring dwelling-houses, they shall order the demolition of the building.

(3) If any owner undertakes to execute forthwith the works necessary to render the dwelling-house fit for human habitation, and the local authority consider that it can be so rendered fit for human habitation, the local authority may, if they think fit, postpone the operation of the order for such time, not exceeding six months, as they think suffi-

cient for the purpose of giving the owner an opportunity of executing the necessary works.

(4) Notice of an order for the demolition of a building shall be forthwith served on every owner of the building in respect of which it is made, and any owner aggrieved by the order may appeal to the Local Government Board by giving notice of appeal to the Board within twenty-one days after the order is served upon him.

Part I provides for the clearing of large unhealthy areas (in urban districts only) (section 3), and the execution of an improvement scheme for the district dealt with.

The authorities empowered to take action under it are the London County Council and all urban district councils or town councils (schedule I).

It is the duty of the Medical Officer of Health when he sees proper cause, or when two or more justices or twelve or more ratepayers in his district complain of any unhealthy area therein, to inspect such area, and make an official report on it in writing to the local authority (sections 5 and 79).

If the Medical Officer of Health represents the area as not unhealthy, twelve or more ratepayers may appeal to the Local Government Board, who, upon security for costs being given, must appoint a legally qualified medical practitioner to report on such area, and the local authority must act on this report (sections 8 and 16).

Improvement Scheme.—Where an area is thus officially represented to be unhealthy, the local authority, if possessed of sufficient resources, must make an improvement scheme. The improvement scheme must be accompanied by maps, particulars and estimates. It need not be confined to the exact limits of the unhealthy area, but may include lands which the local authority consider necessary to the efficiency of the scheme, or for the purpose of providing accommodation for displaced members of the working classes (sections 6 and 11). In default of the local authority making a scheme, it may be made by the Local Government Board and enforced by *mandamus.*

It must be advertised, and the Local Government Board or other confirming authority must hold a local inquiry, and may then make a provisional order confirming the scheme (sections 7 and 8).

The local authority may pull down the buildings, clear out the area and make or widen any necessary streets upon the lands dealt with, after compensating the owners and others concerned (section 12).

Terms of compensation.—Provision is made for the assessment of compensation by the purchase clause in section 21, which enacts :—

(1) that compensation shall be based upon the fair market value at the time of valuation, without any additional allowances in respect of compulsory purchase ;

(2) that in forming the estimate, due regard is to be had to the nature and condition of the property and the probable duration of the buildings in their existing state ;

(3) that deductions are also to be made for existing nuisances :—

  (*a*) for an enhanced value by being used for illegal purposes or owing to over-crowding ;

  (*b*) for the bad state of repair in which the premises are found ;

  (*c*) for the property not being reasonably capable of being made fit for habitation.

The arbitrator may be appointed by the Local Government Board, if so requested by the local authority.

The expenses and income of a scheme under this part of the Act must be carried to a "dwelling-house improvement fund," and the necessary loans may be raised in the ordinary manner (sections 24 and 25).

The Act of 1909 in sections 22 to 27 modifies this part of the principal Act, as regards official representations ; contents of schemes ; loans from the Public Works Loans Commissioners; modification of, abandonment of, or addition to, a scheme; the tendering of evidence to secure reduced compensation; the extinction or modification of rights and easements: the application of money borrowed for the dwelling-house improvement fund; and by repealing sections 9, 17, 18, 19, 27 and 28 varies the procedure as to local inquiries and the service and publication of notices and advertisements.

Re-housing persons displaced.—Accommodation must be provided as follows:—

(*a*) In London, either for the whole or not less than half of the population displaced, to the satisfaction of the Home Secretary, unless it can be shown that within the immediate vicinity the required accommodation has been or is to be otherwise provided;

(*b*) In any other urban district such accommodation (if any) as determined by the Local Government Board.

It will, of course, be noted that the whole question of re-housing under other Acts is regulated by the schedule to the Housing of the Working Classes Act, 1903, which contemplates the provision of new dwellings, in some cases before demolishing the old ones, and requires all houses provided under the Act to be used for working class dwellings at least twenty-five years. By the schedule to this Act—

(*a*) If "thirty or more persons" are to be displaced under Parliamentary powers, the promoters of the undertaking must first obtain formal approval of a scheme for re-housing.

(*b*) In fixing the number to be re-housed, persons of the working classes displaced during the previous five years are to be considered.

(*c*) The conditions under which and the persons for whom and by whom re-housing of displaced persons must be carried out are more clearly and stringently defined (Act of 1903).

Part II has been considerably modified by the repeal of sections 32 and 33 and part of 29 and 39 (5), (6), (8), (9), 47 (3) dealing with closing orders, demolition orders and obstructive buildings, and also by modifications of sections 29, 36, 37 (1), 38, 46, 49 and 51, dealing with the definition of dwelling-house ; making of charging orders ; compensation for obstructive buildings ; confirmation of reconstruction scheme ; enlargement of matters that may be provided for under Part II to the same extent as under Part I ; payments by County and Borough Councils towards Part II, Schemes ; enlargement of time by local Magistrates ; service of notices and description of owner and the inspection of premises by authorised persons.

As amended it provides for—

(1) The inspection of every sanitary district from time to time, with a view to ascertain whether there are any houses unfit for human habitation (section 17 (1), Act of 1909).

(2) The keeping of such records of inspection as the Local Government Board may prescribe (section 17 (1), Act of 1909).

(3) The closing by order of the local authority of any dwelling-house, represented by any officer of the authority as being unfit for human habitation (section 17 (2), Act of 1909). The order to become operative subject to an appeal to the Local Government Board, but without recourse to the Courts of Law.

(4) The demolition by local authority of any dwelling-house where a closing order has remained operative over three months (section 18, Act of 1909).

(5) The enforcement by local authorities of a provision that houses let under certain rentals shall be kept in all respects reasonably fit for habitation (section 75 and sections 14, 15, Act of 1909).

(6) The removal of obstructive buildings (section 38 and section 28 (1), (2) of the Act of 1909).

(7) The re-construction of small unhealthy areas (sections 30 and 40 with sections 23, 24 and 33 of the Act of 1909)

It applies to all urban and rural sanitary authorities, but those in London and rural districts must communicate all steps taken to the County Council (section 45 and Schedule I).

Obstructive Buildings.—The Medical Officer of Health or any four ratepayers may inform the local authority of any building—

(*a*) so dangerous or injurious to health as to be unfit for human habitation ;

(*b*) which stops ventilation or otherwise conduces to make other buildings injurious to health ;

(*c*) which prevents proper measures from being carried into effect for remedying any nuisance injurious to health (sections 31, 38 and 39).

Small Improvement Scheme.—A scheme on the lines indicated in Part I may be passed by the local authority for re-constructing any area, containing buildings, such as thos above-mentioned and must make the required provision for the accommodation of persons of the working classes displaced by the scheme, and allowance may be made to the tenants for reasonable expenses of removal (sections 39 and 40). The Local Government Board will decide as to the part of Act under which proceedings should be taken.

How to get more workmen's dwellings.—This is the most important part of the Act, because it enables local authorities to carry out a scheme to build houses for the working classes. There is no provision limiting the power of the local authority ; no certificate or other formal proof of deficient house accommodation is requisite ; no insanitary property need be closed or demolished. The local authority can decide to build at any time and for any reason which may seem good to it, provided, as in all other municipal work, that the Local Government Board will sanction any necessary loans.

How to get land.—Land can be purchased compulsorily if necessary as provided in section 2 of the Act of 1909 and the Lands Clauses Consolidation Act, 1845, and no lease, settlement, entail or other private arrangement can debar a local authority from acquiring it.

By section 7 of the Housing Act of 1900, land can be acquired for the purposes of this Act either inside or outside the district. The price is to be the "fair market value," with no allowance for compulsory purchase (Schedule I (3), Act of 1909). The value has to be determined in case of dispute by a single arbitrator appointed by the Local Government Board.

What may be done with the land.—Land acquired under Part III may be either—

(1) leased to companies or builders or working men for the erection thereon of workmen's dwellings (section 5, Act of 1900); or

(2) the Council may itself undertake and carry out—

- (*a*) the erection of lodging houses, block dwellings, tenement houses, cottages (sections 53 and 59), and shops for the benefit of the tenants (section 11, Act of 1903);
- (*b*) the purchase and improvement or re-construction of existing lodging houses, dwellings or cottages (section 58);
- (*c*) the purchase or exchange of land for the purpose of encouraging such construction, improvement, or re-construction (sections 56, 57 and 60), and the laying out or construction of public streets or roads (section 6, Act of 1909);
- (*d*) the provision of a garden, not more than an acre in extent (section 53 and section 50, Act of 1909);
- (*e*) the fitting up, furnishing and supplying of the dwellings with all requisite fittings, furniture and conveniences (section 59);
- (*f*) the making of any necessary by-laws and regulations (sections 61 and 62);
- (*g*) the sale of the houses if desirable and necessary after a period of seven years (section 64).

How to get money for land and buildings under Part III.—The conditions as to loans obtained by local authorities are as follows :—

(1) The London County Council may, with the assent of the Treasury, create consolidated stock, and provide for re-payment within 80 years.

(2) London Borough Councils may, if the County Councils think fit, borrow from the County Councils or from the Public Works Loans Commissioners.

(3) Urban District Councils and Town Councils may either borrow from the Public Works Loans Commissioners or issue stock or borrow on security of the rates, subject to the following conditions :—

(1) The consent of the Local Government Board must be obtained.

(2) The period of re-payment of the loan must not exceed eighty years.

(3) Money so borrowed is no longer to be reckoned as part of the debt of the local authority for the purposes of the limitation on borrowing under section 234, (2), (3) of the Public Health Act, 1875.

Under the Act of 1909, Public Works Loans Commissioners may lend up to eighty years, and it is provided that the interest on loans for long periods shall not be greater than for short periods (section 3).

County Councils may lend to societies of public utility (section 72, Act of 1909), who may also borrow direct from the Public Works Loans Commissioners (section 4, Act of 1909).

Housing of the working classes in Indian Cities.

A "dwelling-house" means any building used wholly or principally for human habitation, and includes any yard, garden, outhouse, etc., and the site of the dwelling-house so defined, and includes schools, factories and other buildings where persons are employed.

For census purposes, a *house* is a building under one undivided roof or having two or more roofs connected *inter se* by subsidiary roofs.

A "*chawl*" means a building so constructed as to be suitable for letting in separate tenements, each consisting of a single room or of two rooms but not of more than two rooms.

According to the last official census (1911), in Bombay there are 166,337 occupied one-room tenements, giving an average of 4·47 persons per room, and no less than 76 per cent. of the population live in one-room tenements.

Working Classes in Bombay.—Seventy-six per cent. of the people of Bombay come within the category of working classes, *i.e.*, about 760,000.

Many of the rooms are occupied by more than one family. The rent of these rooms is from Rs. 3 to Rs. 5 *per mensem*; the average monthly wages of this class is Rs. 20 *per mensem.*

Working Classes in England.—The conditions under which the working classes live in Western cities do not vary much. Their habits, customs and mode of living are the same, the only difference being the variation in the cost of living and the frugal tendency of some places and the rate of wages.

The Indian is well-known to be gregarious in his habits; he follows the leader. As a result of caste and customs, the working classes in large cities in India, like Bombay,are made up of different divisions of the backward classes, and each division is governed by its own customs, habits and caste prejudices. The mode of living is also not the same, as they live under different conditions of life.

In consequence of these differences, there is the obvious necessity of housing each section under conditions suitable and favourable to each particular division. For housing purposes it is therefore necessary to divide the working class population of a large Indian city, like Bombay, into divisions, governed by their own customs and habits. Fully over three-fourths of the population of Bombay is comprised of the working classes, the majority being Hindus as compared with Mahomedans.

(1) *Hindus.*—These chiefly consist of the depressed and backward classes, *i.e.*, (1) Mahars, (2) Chamars, (3) Mangs, (4) Dhers. These come into the City in search of labour and subsistence from villages in the Konkan and Deccan. The last sub-division (Dhers) includes those coming from Kathiawar. This division supplies labour (*a*) to Docks—as dock labourers, coal fillers, etc.; (*b*) to Municipality and Railways for scavengering, conservancy, etc.; (*c*) in other miscellaneous works—as laying drains, sewers, filling up, excavation, etc.

The housing of these people has so far been found a most difficult task, as no other community will live in close proximity to them. The conditions under which the individuals of this division live requires a little description. They live all huddled together in the open, or mat-huts, or *chawls* set apart for these people only. Families live promiscuously. Their personal habits are very filthy and they seem to flourish in squalor. The individual cost for maintenance is infinitesimal. They live on almost anything. Nothing is prohibited to them by religion or caste. Caste as such does not exist with them. Everything is welcome, from dead meat to leavings of eating houses, *Mahajan Wadis* and hotels. In chawls they live in single-tenement rooms, generally dark, ill-ventilated, damp and over-crowded. The average monthly wage of this division per individual ranges from Rs. 8 to Rs. 12, the lower figure being that for female labour.

The *Marathas* form the second great division of the working classes; they supply domestic servants, mill-hands, coolies, weight-carriers in grain godowns, in the docks and cotton-greens; they are also engaged in all petty businesses, as vegetable dealers, fruiterers, grocers, bullock-cart drivers and masons. Their average monthly wages vary from Rs. 12 to Rs. 25 per individual, depending upon the nature and quality of work. They come from the Deccan or Konkan. The Deccani Marathas are a very hardy and sturdy lot, not afraid of any hard work and always doing it cheerfully. The Konkani Maratha is of a smaller and a weaker built and generally works in mills or in domestic service. The Maratha female is a helpful mate, contributing between

Rs. 10 to Rs. 12 or a little over towards household expenses. The actual cost of living to a Maratha is an expensive item. The cost of living for each working individual is about Rs. 9 for only bare necessities. The Marathas are very conservative in their habits. They eat only what is cooked at home or by their caste brethren. They generally live in *chawls* in single tenement rooms, paying rent on the average between Rs. 3 and Rs. 6, depending on the size and its sufficiency for accommodation of a family which may consist of 8 to 10 members. The increase in rents with the recent rise in valuation of landed property tells heavily on their meagre income. The class of labour they give in return for wages is of a superior kind and more thorough as compared to that of the first division. These people are also of cleanlier habits, both personal and domestic, and, as a rule, are not lazy or indolent. The Maratha also supplies a certain amount of skilled labour and a large proportion goes to fill up the ranks of the native police constabulary. The latter are provided by Government housing accommodation in Police *chawls*, a step in the right direction and an example to be followed. As housing accommodation is needed, it should be provided by the large employers of labour on sanitary lines, which would yield a sufficient and reasonable profit.

The third great division of the working classes comprises the Mahomedan element. This division may be subdivided into groups—those earning between Rs. 10 and Rs. 20 and those earning between Rs. 20 and Rs. 50. The latter group will be separately described. The Konkanis supply domestic servants, office *pattawalas*, boatmen lascars and policemen. When not with their families they club together in rooms; the number thus accommodated varies from 20 to 50 persons according to the size of the rooms. If accompanied with a family, a single-tenement room is engaged; the majority of such rooms are dark, damp and ill-ventilated and scarcely sufficient for the members of the family, therefore generally over-crowded. The rent varies from Rs. 3-8-0 to Rs. 4-8-0. Their mode of living is very poor; cheap and dried fish is the chief element in their food-stuffs. The Konkani Mahomedan is lazy in his habits, as compared to his Deccani *confrère*. The latter is more aspiring and ambitious. Hence he apprentices himself to some trade or business, and most of these earn a higher wage, ranging from Rs. 20 to Rs. 50. By occupation they are generally fitters, plumbers, joiners, carpenters, turners and factory hands. They generally house themselves in double-tenement rooms, paying a rent of Rs. 8 to Rs. 10. The double-tenement rooms consist of one living room, 10′ × 10′ × 10′, and one smaller, the cook-room. The latter provides also a small *nahani* or bathing place. The double-tenement, as at present obtaining, does not provide healthy accommodation, as the rooms are dark and ill-ventilated and most of them abut on common house-gullies. Those abutting on the street may be called superior in comparison, but their rents are higher, from Rs. 10 to Rs. 15. At present, advantage is taken by these people of the better housing accommodation provided in the Improvement Trust *chawls*, where they happen to be in close proximity to Mahomedan localities. They have learnt to appreciate this improved accommodation, and the rooms are readily taken up by them. Among the working classes should also be classified clerks and artizans, bricklayers and victoria drivers, belonging to all denominations, whose monthly wages range between Rs. 25 and Rs. 60. These generally occupy double-tenement rooms, the rent of which averages between Rs. 10 to Rs. 15. The actual cost of living per each adult individual is about Rs. 15 for only the bare necessities of life. With the exception of those abutting on streets, the rest have insufficient light, and the ventilation is vitiated by the windows abutting on common house-gullies in which basket privies abound. The house-rent of the rooms occupied by this class is by about 60 per cent. higher as compared to a decade ago. This class—specially clerks—are generally weakly built and of insufficient energy; after continued work of about a year they generally suffer or become apathetic and slow and slack at work. They cannot save anything. For this class of people flats should be provided with double-tenement rooms having plenty of light and ventilation. The rent must not be over Rs. 10.

Working classes in large cities in India live an artificial life in houses and under conditions to which they are unsuited, and which render any attempt at sanitation most difficult. It is the custom for several families to live, cook and sleep in the same room.

Insanitary Conditions.—The relation between over-crowding and insanitary conditions and a high mortality has been dealt with by all sanitarians from time to time. In cities in India a high mortality follows closely insanitary surroundings, absence of domestic and personal hygiene, want of ventilation and light and the presence of filth ; in fact, the incidence of disease is directly related to the insanitary domestic surroundings—the incidence varying with the habits and customs of the people with regard to their food, personal cleanliness, domestic habits, washing, bathing, cleaning of rooms, clothes and persons, habits of living and sleeping ; with accumulation of material and filth harbouring vermin, condition of floors, of wall and ceilings of houses ; and with prejudice against the measures for improvement or any attempt to remove what is considered the cause of the spread of disease.

Insanitary surroundings may then be termed anything or any condition which tends to impair health, and among the chief factors which conduce to it are poverty and ignorance. Of the total influence which these surroundings exert on the health of the people exposed to them, no exact statement can however be given. That they produce disease and a certain amount of disablement is undeniable, but it is only so far as the varying incidence of such sickness is ascertained and the disease kills that the effect can be represented in numbers.

Insanitary surroundings may be divided into external and internal. *External* conditions include :—

(1) Sanitary defects in areas, dense aggregation of houses, congested areas and, as a result, inadequate open spaces about dwellings, insufficient light and air.

(2) Dampness of soil.

(3) Want of drainage or defective drainage leading to pollution of soil.

(4) Defective means for removal of excreta and polluted matter, street sweepings, trade and domestic refuse.

(5) Defective sanitary laws and the difficulty of applying them.

(6) Habits and customs of people, religious and other prejudices with regard to exposure of infected persons and things.

Internal conditions have reference to (1) Over-crowding in houses and rooms. (2) Ventilation of rooms.

(3) Dampness of rooms. (4) Lighting of rooms.

(5) Character of the floor and wall. (6) Method of collecting rubbish in rooms. (7) Cleanliness.

(8) The harbouring of vermin on bodies and clothes.

(9) Clothing of persons. (10) Washing and bathing.

(11) Occupation and habit. (12) Skin diseases due to climate and clothes and habits inducing facilities for contracting Plague. (13) Custom in the preparation of food and food-stuff.

Such insanitary conditions are, as is well-known, powerful predisposing causes in the production of Phthisis, Pulmonary Diseases other than Phthisis, Diarrhœal Diseases and Fevers and epidemic diseases generally; and a reference to any statistical table in the report of various Health Departments all over the world will show that in areas with such insanitary surroundings the sickness and death-rates are considerably above the average, and when those areas have been improved by sanitation, the mortality and sickness, both general and zymotic, have been reduced.

As an illustration of this in Bombay, take one section of the City where sickness and mortality have always been high—Kamatipura.

The streets in Kamatipura are well arranged and fairly numerous, there being sixteen running across it from east to west and five from north to south. There is no uniformity about the houses and they vary much in shape and size. Most of them are sub-let in separate tenements and are occupied by persons of the poorer classes. Many of these *chawls* are unfit for human habitation, either wholly or in part, owing to radically defective construction.

Over-crowding is undoubtedly the chief cause of the unhealthiness of Kamatipura. This term is applied to two distinct conditions which, however, are invariably associated together. The one has reference to land, upon which the houses are situated in such close approximation that the provision of air, light and space is reduced to a quantity below the standard requirements of health ; the other to houses in which the inhabitants exceed in number the accommodation. Both these conditions obtain in an exceptional degree in Kamatipura. The houses are built almost back to back, there being only a narrow passage between the row of houses in one street and that in the next. The depth of houses from front to back is excessive, and usually the whole of the available space behind the street frontage is occupied by the building itself ; the privies in many cases are not properly detached and the air of the dwelling is continually charged with the most noisome odours. There is rarely a gully at the sides of houses, and when one exists it is generally not more than two feet in width. As a result of this the buildings as a whole are deficient in light and ventilation, the centre rooms being often in absolute darkness, and dependent for ventilation upon the passages within the houses. Speaking generally, the gullies are open channels for carrying off sullage, but usually they are so imperfectly paved as not to be water-tight, and sometimes they are not laid with a proper fall towards the street drain. Many of them serve as passages for sweepers and are flanked on either side by a long row of privy shafts. In such cases the trap doors of the shafts abut immediately on the gully, and when the receptacles get full and overflow, as they frequently do, the liquid filth is discharged on the surface of the gully. Refuse of all kinds is also thrown into the gullies by the people living in the adjoining houses. For these reasons the gullies, though repeatedly cleansed, are generally in a dirty and foul condition, and windows which overlook them have to be kept closed to exclude the smell. Such gullies are therefore of little use for purposes of ventilation. Moreover, owing to the structural defects pointed out above, liquid filth is not carried away but stagnates in the gullies, and the foundations of the houses and the soil around them are continually receiving what to all intents and purposes is the soakage of sewage. In this way the soil and sub-soil are fouled and rendered damp, and the level of the ground water is raised. Throughout Kamatipura this dampness of the soil can be observed, and water is to be found within a few feet of the surface. As a result, dampness of ground floors is a noticeable feature in nearly all the houses, even in those with substantial plinths and paved or cemented floors.

Population (1911).	Increase or decrease since 1906.	Density per acre.	Birth-rate (1911).	Infant mortality per 1,000 births registered (1911).
36,751	+267	555·6	22·72	419·1

These conditions prevail, though in a modified form, in Calcutta and Madras, Delhi, Ahmedabad and any other large cities in India, but in Bombay only are large *chawls* found which are built to economise space, the land being more valuable.

Houses unfit for human habitation.—In dealing with insanitary dwellings, the question of what constitutes a house unfit for human habitation is an extremely difficult one. No scientific standard is or can be applicable. Every sanitary circumstance has to be taken into account. What would be considered unfit in Western countries would be fit in the East, where conditions of climate are so different.

According to the Public Health Act, in England any dwelling house that appears to be in a state dangerous or injurious to health is considered to be unfit for human habitation.

Under the Bombay Municipal Act, Section 378, buildings unfit for human habitation are thus dealt with :—(1) If for any reason it shall appear to the Commissioner that nay building intended for or used as a dwelling is unfit for human habitation, he shall give to the owner or occupier of such building notice in writing signifying his intention to prohibit the further use of the building for such purpose, and calling upon the owner or occupier of such building to state in writing any objection thereto within thirty days after the receipt of such notice; and if no objection is raised by such owner or occupier within such period as aforesaid, or if any objection which is raised by such owner or occupier within such period appears to the Commissioner invalid or insufficient, he may with the previous approval of the Standing Committee, by an order in writing, prohibit the further use of such building as a dwelling:

Provided that, before such approval is given, the owner or occupier of the building shall have the right of appearing before the Standing Committee in person or by agent and of showing cause why such approval shall not be given.

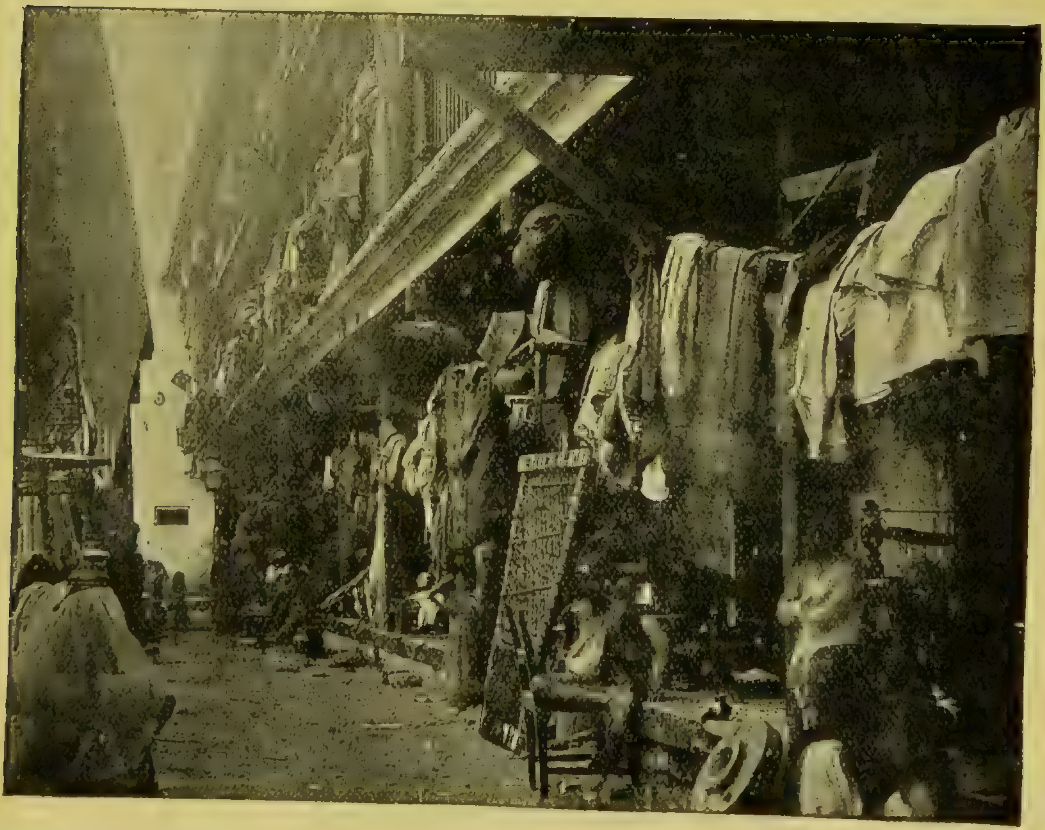
(2) When any such prohibition as aforesaid has been made, the Commissioner shall cause notice of such prohibition to be affixed to and the letters "U. H. H." to be painted on the door or some conspicuous part of such dwelling, and no owner or occupier of such building shall use or suffer the same to be used for human habitation until the Commissioner certifies in writing that the causes rendering it unfit for human habitation have been removed to his satisfaction.

House Inspection:—In dealing with insanitary houses for the purpose of condemning them as "U. H. H.," a systematic house inspection must be made.

House inspection has reference to—(1) the arrangements for preventing the contamination of the water supply; (2) the closet arrangement; (3) drainage; (4) the conditions of the dwelling-house in regard to light, the free circulation of air, dampness and cleanliness; (5) the paving, drainage and sanitary conditions of any yard, compound or outhouse belonging to the dwelling-house; (6) the arrangements for the deposit of refuse; (7) the existence of any room if it be so dangerous and injurious to health--a room habitually used as a sleeping place which is not on an average at least 7 feet in height from floor to ceiling or does not comply with such regulations as the local authority may prescribe for the proper lighting and ventilation of such rooms and the protection thereof against dangerous effluvia or exhalations; (8) any defect in other matters which may tend to render the dwelling-house dangerous or injurious to the health of an inhabitant.

Thus in reporting on a house as "U. H. H.," many tenements—single rooms—may be fit, while others may be unfit for all or any of the reasons given above.

The native working men and women for domestic reasons object to light and air, and it is common to see even the model Improvement Trust chawls with rags or bags stretched across the windows.



IN A TOWN.

They do not seem to require light or air and we must not consider everything has been done when we have caused every house and room to be rebuilt up to 63½-degree-scale standard.

The only education in sanitary matters these people understand is laws and bye-laws, and this is the form education should take in housing the poor.

What the native workman is satisfied with is a room 10′ × 10′ × 10′, a small *verandah*, a *nahani* and a small room for cooking where to stack his wood, cowdung cakes, pots and pans, and perhaps keep fowls and goats, a loft to store wood or lodge boxes, rags or logs.

More often than not, the cooking is done in the living room and the smoke escapes into the passages or out of the window. The floor is used for sleeping where circumstances do not permit of a charpoy; the baby is slung in a cot or lies on the floor; the floor is cow-dunged regularly and also the walls. The *nahanis* are misused by the children and for washing and for stacking firewood; the refuse is thrown out of the window. Water is stored in an earthen vessel in the *nahani* and the pots and vessels cleaned there, or taken out to the street or nearest bathing place. The privy accommodation may be a water-closet or a privy basket, situated at the end of the passage adjoining the common bathing room, which is crowded with men and women fighting for water and washing vessels and their clothes.

In the majority of these dwellings it is impossible to see in any of the rooms or passages in the day-time or to get through them without a lamp.

Type of working class dwellings required.—For eight months in the year in Bombay, Calcutta and Madras many people sleep in the open paths, streets, oarts and *wadis*.

The working man in large cities in India could be suitably housed in a room 10′ × 10′ × 10′ for family—man, wife and two children as the maximum number of inhabitants. The room should be so arranged that at least one side should abut on an open space 20 feet from any other building, well lighted and ventilated, and, if the rooms are in two rows opening into a passage 10 feet wide, they should be provided with a ventilator of at least 3 square feet in area near the top of each of the two walls of such rooms. Such ventilators should be opposite each other. The walls should be of brick, cement, concrete or other impervious material; the ceiling and the floor of tiles or cement and stone with a smooth polished surface with rounded corners; a window carried up to the ceiling and made to open, top and bottom, with half doors. The foundation should be of concrete with a plinth 2 to 3 feet high.

The ideal building should be rat-proof, but this ideal cannot be lived up to in a large city in India.

The closet arrangements must be determined by the water-supply and drainage system, but in all cities where such a supply is sufficient for the purpose, the water-carriage system is strongly advocated.

In cities where the water carriage system is provided, proper accommodation should be given for bathing and washing places in the compound or the space around the building.

If facing the rainy quarters, the rooms should be provided with movable shutters.

The building should not be more than one storey: ground and first floor; not more than 20 rooms in each block. Each block should be at least 20 feet apart and erected in such a position as to have breeze, light and air. The space around the building should be paved with asphalte or tarred.

There should be open space enough for children to play. This can always be arranged in laying out blocks.

The erection of huge blocks of buildings is contrary to the habits of the people, prejudicial to health and difficult to control; as a question of expense and owing to the initial cost of land, over-crowding of houses or areas is considered by some as a necessity. From the point of view of the owners of the buildings this is financially sound; where the land has a value of Rs. 250 to Rs. 500 a square yard, it is easy to imagine that the owner or lessor wishes to reap as much as he can. But in India, even in Bombay, where these houses have been allowed to be built, such excuse should not be tolerated. The erection of such dwellings reduces the value of the locality by over-crowding ; they reduce the vitality of the inhabitants and foster disease, thereby reducing the number of workmen available and the amount of labour from each workman.

If certain parts of the city were set aside for erecting dwellings on sites which could be adapted and where land is cheaper, those parts of the city which are now covered with over-crowded insanitary areas could be vacated, a better class of buildings erected with better tenants and would ultimately give better financial results. *For example.*—The dock labourers should be housed near the docks, the mill-hands near the mills, the general labourers in those parts of the town where land is cheaper. The clerks, etc., on sites easily accessible by tram or rail.

The most important section of the Town Planning or Housing Act is for improving old towns. In India it is that referring to the erection of workmen's dwellings and the policy of assisting migration from over-crowded insanitary areas in the expensive part of the city to other sites more remote, where fresh air, light and space can be had, where dwellings can be erected cheaply in one-storeyed blocks capable of supervision. The argument against this is that the people will not live away from their work. This is proved to be incorrect in every city where it has been attempted.

The tendency of commercial enterprise is to erect factories, mills and large industries outside of the city proper where the land is cheaper, rates and taxes less.

The policy to be followed.

All municipalities should be empowered to acquire land and erect thereon workmen's dwellings either as a municipal concern or advance the money on certain conditions to responsible bodies or individuals. This will prove cheaper in the end than to acquire existing insanitary areas and to rebuild them.

The course of procedure should be as follows :—

Laws and bye-laws should be made under which the Health Officer, through the local authority, is bound to report on any insanitary dwellings which come to his notice. A representation should be made to the governing body. Action should be taken against the owner. Notice should be given stating the condition of the premises, after due notice the dwelling-house should be declared as "U. H. H.," or the area insanitary. Action for closing and demolition and rebuilding should be carried out according to laws and byelaws. In many cities thousands of such houses exist and such work is daily going on. The local authority lays down a standard to which the owner of the condemned house must conform. It is impossible for him to comply with it, owing to the existence of adjoining houses which just come within the municipal requirements; what can he do? He cannot build a new house on a reduced area according to the prescribed standard which will bring him the same rent from the old dilapidated houses in which the poorer people lived. Moreover, the local authority has decided that in this area certain restrictions are to be imposed as to light and air, height of houses, width of streets, open spaces, class of buildings, shops, factories and godowns under the Town Planning Act. He therefore sells his land or acquires the adjoining house and builds according to the standard laid down.

Provisions regarding the Ventilation of Buildings in Towns.

1. *Building Sites.*—It should be enacted that every new building or compound in which a building is to be erected must abut on a street of at least 40 feet in width, and where no such street exists, a line must be laid down and the owners of the properties adjoining this line must leave sufficient land for the construction of the street. It should rest with the Municipality to decide whether a new public street should be laid out or not, and in the event of this being done, there should be an obligation to acquire the land left vacant within a fixed period, say two years after the completion of the building, or in default to pay reasonable interest on the value. When the street is to be a private street, the owners of the land must be under an obligation to construct it within a reasonable time in each case. All applications to build, in which the above conditions are not satisfactorily provided for, should be liable to rejection.

2. *Height of Buildings.*—It seems desirable in the first instance to provide that, except in the case of specially exempted buildings, such as public buildings or buildings for which special architectural features may be sanctioned, a certain maximum height should not be exceeded; and this should be fixed at 70 feet up to the tie-beam of the roof or place where a tie beam would ordinarily be. The roof should not be allowed to rise above that at an angle to the frontage greater than 45°. Where the roof is a flat one, a parapet three feet in height may be allowed above the maximum limit fixed. The height of buildings should be further limited according to the width of the street on which they abut, and modern expert opinion seems to be in favour of prescribing that the height of a house should not exceed the width of the open space in front of it. Rule 2 contained in Schedule XVII to the Calcutta Municipal Act of 1899 seems to be very suitable:—

" 2. (1) If a building is situated at the side of a street, " no portion of the building shall intersect any of a series " of imaginary lines drawn across the street at an angle of " 45 degrees with the plane of the ground, such lines being " drawn from the street alignment on the side of the street " which is the more remote from the building in question, " at the level of the pavement or of the centre of the " street.

" *Explanation.*—If a building be placed at the edge of " the street, its height must not exceed the width of the " street; but if the building or one or more of its storeys " be set back, the height of the building may be increased, " subject to the condition that no portion of the building, " after the height is increased, intersects any of the aforesaid lines.

" (2) In the case of any building which is re-erected in " a street, in existence at the commencement of this Act, " which is less than 25 feet wide, the angle at which the lines " referred to in sub-section (1) are to be drawn shall be 36½ " instead of 45°:

" Provided that nothing contained in this sub-rule shall " authorize the erection of any building so as to make it "higher than any building which at the commencement of "this Act is standing on the same site.

"(3) Notwithstanding anything contained in sub-rule "(1) or sub-rule (2), the Corporation may, by order published "in the *Calcutta Gazette,* declare that in any street in existence at the commencement of this Act, which is specified "in the order, the erection of two-storeyed buildings not "exceeding twenty-eight feet in height will be permitted "without complying with the requirements of those sub-"rules.

"(4) If a building is situated on a corner plot so as to abut "upon more than one street, the height of the building shall "be regulated by the wider of such streets so far as it will "abut or abuts upon such wider streets, and also so far as "it will abut or abuts upon the narrower of such streets "to a distance of 40 feet from such wider street.

"The sub-section is not applied to buildings of the ware-"house class erected in localities specially set apart for build-"ings of this class."

The Calcutta Building Commission point out that the 45-degree rule has been adopted by the Calcutta High Court as showing what amount of light and air is necessary for the convenient enjoyment of a house. The same standard should be adopted in Bombay and other large cities. In the case of buildings on sites already built on, the limit might be fixed at one-and-a-half times the width of the street, where the height of buildings already existing on such sites is up to that limit at the time of passing of the new rules.

3. *Exterior open spaces and interior open spaces.*—It must be obvious to any one acquainted with cities in India that sufficient light and air cannot be obtained from gullies varying from 2 to 5 feet in width, and that where these gullies are used as open drains, as they usually are in Bombay, it is most undesirable to have openings on them. It is unfortunately impossible, from a practical point of view, to attempt to stipulate that no house shall have a depth of more than two rooms to be lighted and ventilated from open spaces on streets at the front and back respectively. Failing this,

however, it is essential to make proper provision for the inner rooms, and the following main points should be observed in the case of domestic buildings :—

(*a*) The whole of at least one side of every room should be an external wall abutting on the open air or should abut on an interior open space.

(*b*) Such external wall when situated at the side of the building should abut on an open space of not less than ten feet in width, extending along the whole length of the wall and belonging exclusively to the building. In this space no open drain except for rain-water should be allowed.

(*c*) Every interior open space referred to in (*a*) above should have a minimum superficial area of one-fourth of the aggregate floor area of all the rooms abutting thereon, and a minimum width of eight feet, and should be open to the sky and free from any erections or encroachments of any kind. The height of any face of a dwelling abutting on such open space should not exceed twice the width of the open space measured from such face to the opposite face, but when a dwelling house has more than two storeys, the storeys above the second should not be taken into account in applying this rule as to height if they are built on not more than two sides of the house.

(*d*) At the rear of the building there should be an open space exclusively belonging thereto of an aggregate area of not less than 150 square feet, of at least 10 feet in width, free from any erection, and extending laterally throughout the entire width of the building. The minimum distance from every part of such building to the boundary of any land or premises immediately opposite or adjoining thereto should be—

fifteen feet, if the height of the building be fifteen feet ;

twenty-five feet, if the height of the building be twenty-five feet ;

twenty-five feet, if the height of the building be thirty-five or over.

As in the case of the front part of a building, the height of the part at the rear should be limited with reference to the width of the permanently open space on which it abuts and, as provided in the London and Calcutta regulations, no part of the building should extend above a line drawn at an angle of sixty-three-and-a-half degrees with the plane of the open space, at the level of the plinth, from the boundary of such open space furthest from the building.

4. *Height of rooms.*—A minimum height of 10 feet is required except in the case of rooms in the roof for which an average height of 8 feet is prescribed. The 10 feet is measured from floor to ceiling except in attics.

5. *Superficial area of rooms.*—This should be increased from 80 to 120 feet.

6. *Area of opening for purposes of ventilation.*—Doors should be left out of account and windows or gratings equal to $\frac{1}{10}$ of the floor area of the room should be enforced.

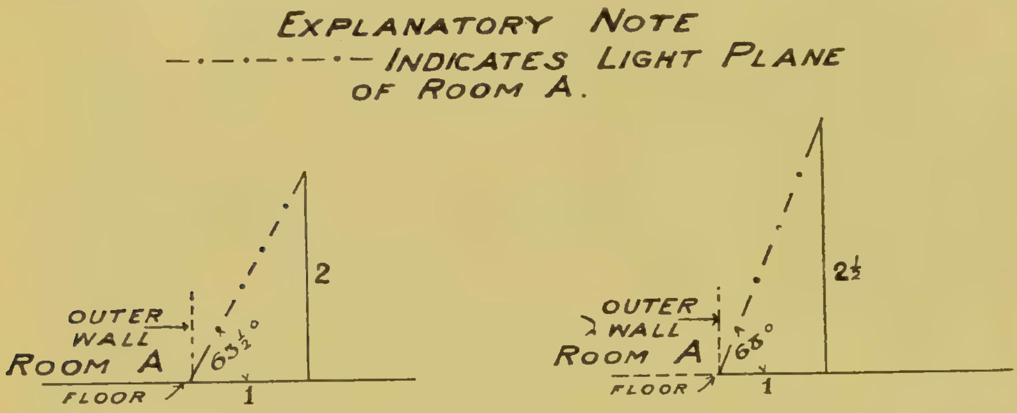
7. *Width of Streets.*—The same limit should be prescribed in the case of new private streets or accommodation roads as now obtains in respect of new public streets.

8. *Proportion of sites to be built on.*—In the case of sites used for dwelling houses, the total area occupied by buildings should not exceed two-thirds of the total area of the site

9. *Over-crowding.*—In the extension of existing towns or the improvement of insanitary areas, it is very desirable that there should be one standard of light and ventilation. The standard which has long been enforced upon Improvement Trust estates, and which is also now enforced under Municipal Bye-laws all over Calcutta, and in most of the important towns in England, is commonly known as the $63\frac{1}{2}^\circ$ standard. Roughly, it means that throughout the length of one side of every living room there shall be external air-space open to the sky extending to a distance, measured horizontally from the room-wall, of at least half the height of the top of the opposite house above the floor of the room. It is called the $63\frac{1}{2}^\circ$ rule, because the angle at which light from the minimum air space

so prescribed will strike the floor is an angle of approximately 63½°, which has a tangent of 2 to 1.

Thus, if a gully between two houses is only 10 feet broad the height of each house above the plinth must be limited to 20 feet, if the lowest rooms are to satisfy the 63½° rule; and if two houses of the maximum height ordinarily allowed in Bombay, *viz.*, 70 feet, are built side by side and have side rooms depending upon the space between the houses for their light and ventilation, then to satisfy the 63½° rule that space must be 35 feet broad.

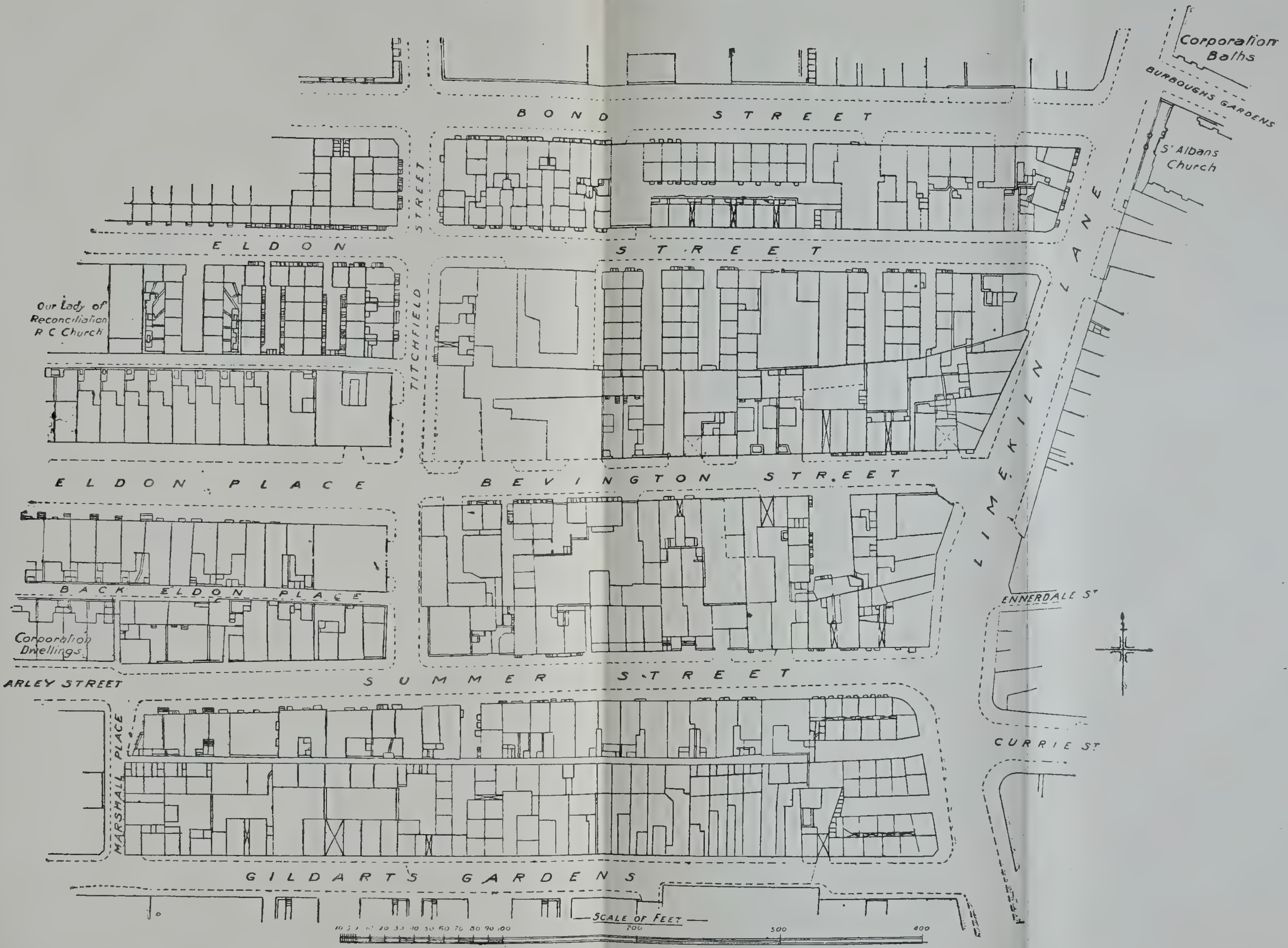


Not more than one family should be allowed to reside in each room; for each adult a floor space of 25 superficial feet and for each child under 10 a floor space of 15 superficial feet should be required, and for each adult a cubical space of 250 feet, and for each child under 10 a cubical space of 150 feet, exclusive of any part of the room more than 10 feet from the floor, should be enforced.

10. *Certificate of Completion.*—Within a reasonable time after the completion of any building, the owner should be bound to give intimation to the Commissioner and should give all necessary facilities for inspection within a month after the intimation is given. If on inspection it is found that the work has been done in accordance with the sanction and so as not to contravene any of the provisions of the Act or bye-laws, a certificate permitting the occupation of the building should be given. If these conditions have not been fulfilled, there must be power, as at the time of construction, to require the necessary alterations to be made.

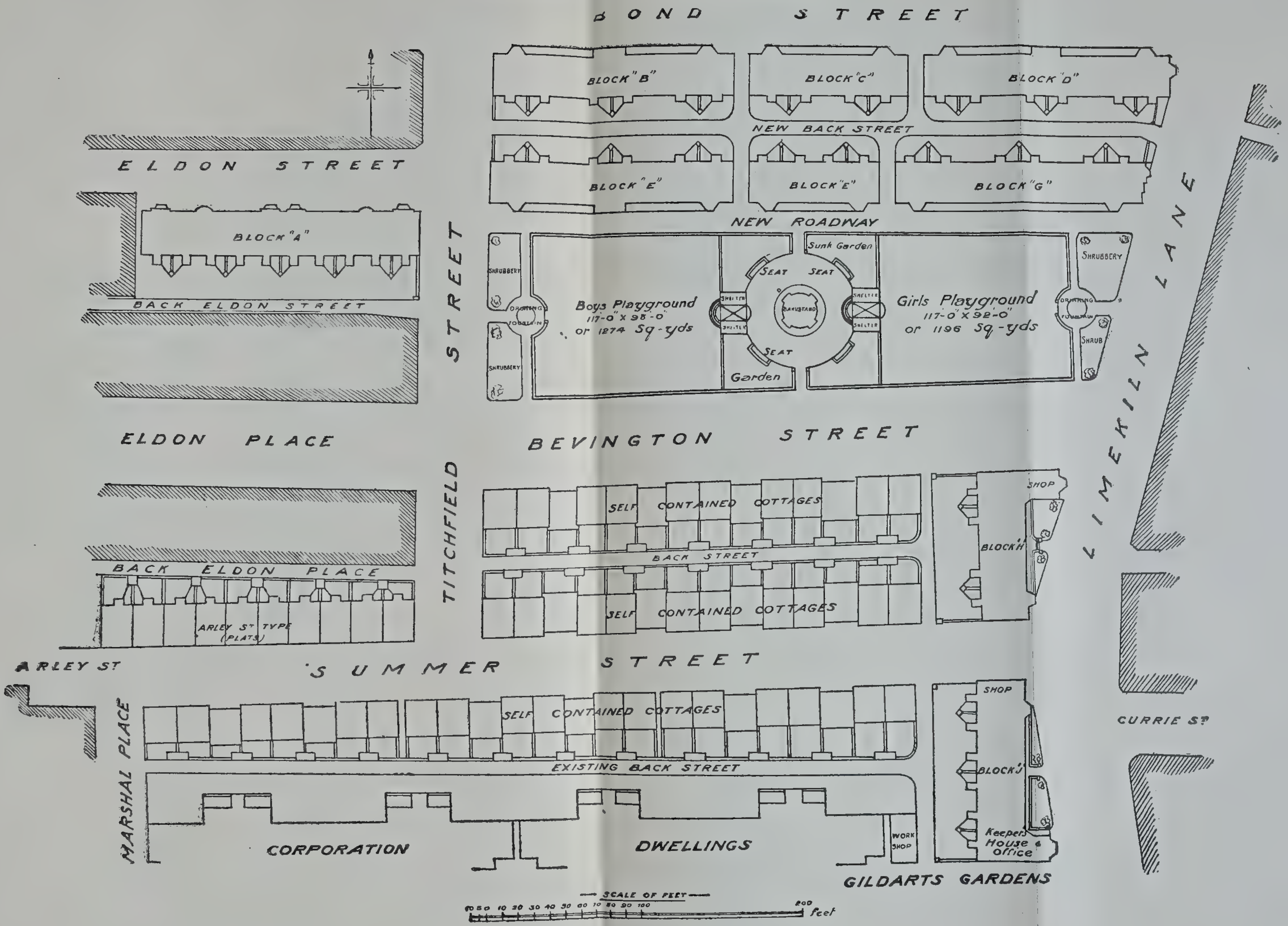
CITY OF LIVERPOOL.

Unhealthy area before improvement.



CITY OF LIVERPOOL.

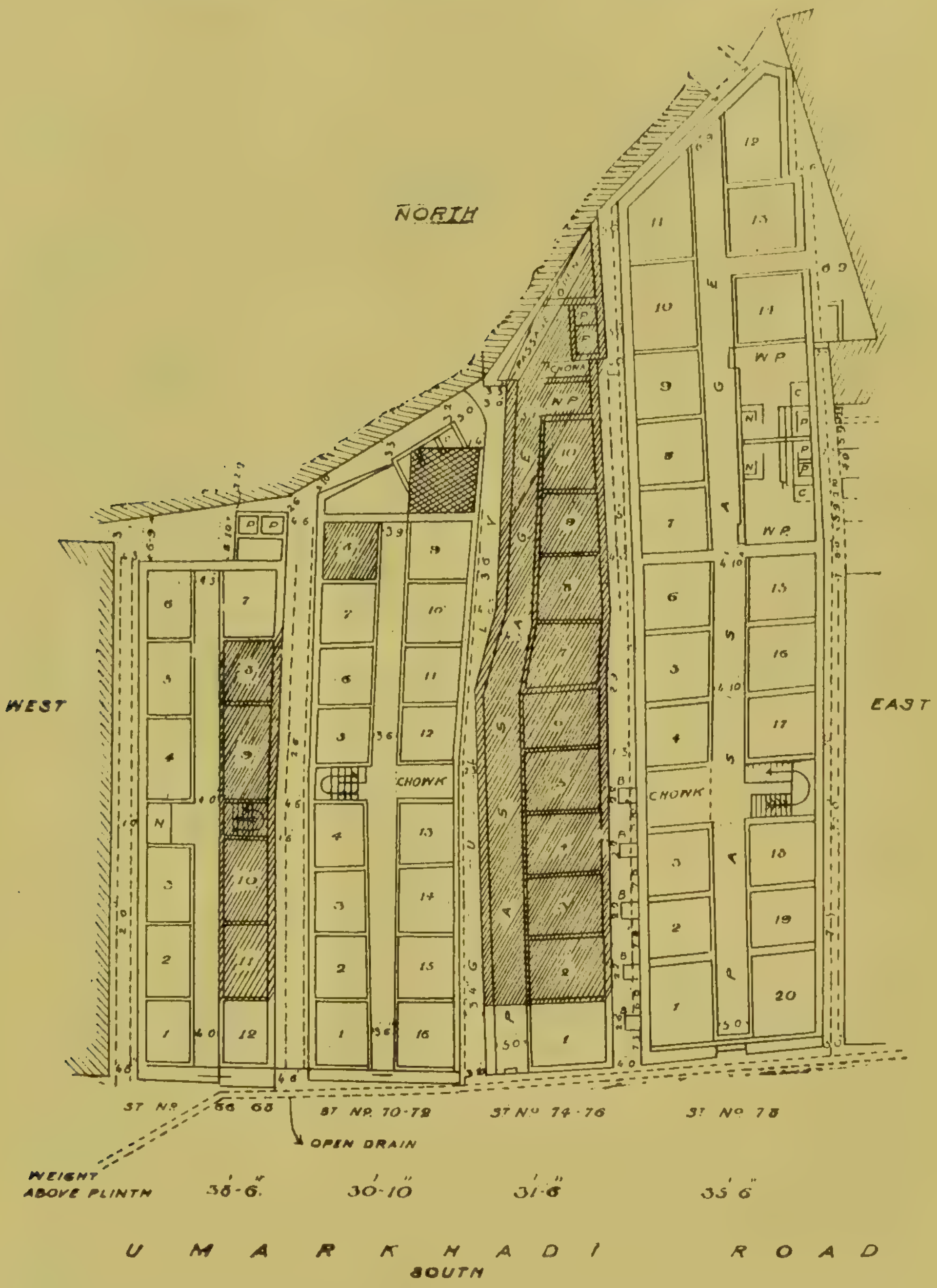
The same area after improvement.



1929

CITY OF BOMBAY.

Unhealthy area notified for improvement.



NOTE :—

Hatched areas indicate properties which must be acquired and cleared of buildings.

Crossed hatched area indicates site available for extension of existing building.

Dotted line indicates projections of eaves.

B. indicates ground floor Buttress.

20 FEB. 1920

CHAPTER XIII.

VITAL STATISTICS.

Vital statistics may be defined as the science of figures applied to the health history of communities. They deal with the principal events or phenomena of human life, births, marriages and deaths, the various diseases from which people suffer or die, together with the influences which affect vitality. In other words, the units of which they are composed consist mainly of persons living and of persons dying, and these units are classified or grouped under certain characteristics, such as age, sex, occupation, disease, etc., etc. The analysis of these units or elementary facts observed in their various relations to time and place and dealt with according to strict numerical method lies at the foundation of all sound enquiry and supplies the only true criterion of sanitary progress. The collection and publication of vital statistics serve in a considerable degree to stimulate public interest in, and attention to, matters affecting the public weal, and in the hands of health authorities they direct attention to the health of the people and conditions which adversely affect it, thus enabling precautions to be taken and, in respect of trades attention is early directed to any particularly dangerous ones, and subsequent investigation then suggests the lines on which preventative legislation should be based. Statistics of sickness, apart from mortality, have not as yet been attempted on a large scale, on account of the difficulty of collecting data. Such returns would be of great use in helping the solution of the problem of the influence of varying conditions of climate, soil, season, prosperity, race, etc. At present, however, compulsion is exercised only in respect of certain dangerous infectious diseases. This information is enforced so as to enable the authorities to take measures for the prevention of the spread thereof.

Vital statistics in India, except in a few of the larger Presidency towns, are of little value as an index to the real health conditions of the country. Even in Bombay, Calcutta and Madras, where laws exist for regulating the registration of births and deaths and sickness, elaborate systems have to be employed for collection and verification, owing to defects in the particular law and the ignorance and resistance of the people to voluntarily report deaths, births and sickness.

The methods employed in other countries in the compilation of statistics cannot be relied on in India as an accurate basis for calculation, and no comparison can be made between Eastern and Western figures. Except in the larger cities mentioned, the fallacies of averages and rates are greater. For these reasons the causes given for an increasing death-rate or diminishing birth-rate or an increasing population in Western countries do not apply equally to the East. The circumstances of early marriage, pestilence and famine, Plague and Cholera, a high birth-rate and conjugal condition have to be considered in the East.

In India all women practically begin child-bearing at a very early age and, the birth-rate being high, the increase in the population is kept in check by the enormous infant mortality. No prudential motives enter into the domestic life of the ordinary Indian, the checks on the population being pestilence and famine, a high infant mortality, premature birth, unskilled midwives and insanitary surroundings, poverty, ignorance and superstition.

SOURCES OF INFORMATION.

For the purposes of the sanitarian the main sources of information are the census, the returns of marriages, births and deaths, the notifications made under the various notifications of Infectious Diseases Acts, and the returns made under the Factory Act relative to poisoning from certain metals, etc., *e.g.*, lead, arsenic, mercury, phosphorous, and the disease Anthrax. As all these returns particularise the locality of each unit, whether supplied by census or by registration or notification, the units themselves can be readily classified according to the various divisions or subdivsions of the country, such as counties, towns, parishes, villages, streets.

The essential basis of all vital satistics is the possession of an approximately accurate knowledge of the population.

THE CENSUS.

It need hardly be said that the taking of a census is not confined merely to taking a count of the people as, amongst other items, the schedule returns contain particulars of the name, sex, age, rank or occupation, condition, relation to the head of the family, and the birth-place of every person passing the night of the date of enumeration in every house throughout the land. The census in England was first taken in the year 1801 and has been taken every tenth year since that date. It is taken in the first year of a decade and at the end of the first quarter of that year, *i.e.*, at the end of March. In very few places is the population stationary: it usually decreases or increases ; if no such variation took place, then, of course, the number found at the last census would be correct for intercensal years; but in practice it is usually found necessary to calculate the number of people for the years and the fractions thereof between the censal years. Any increase in the recorded population may be either natural or actual.

Natural increase :—By this is meant the excess of births over deaths in any place in a given period of time, whereas an actual increase depends on the balance between births and immigration on the one hand, and deaths and emigration on the other. As a general rule, in towns, the actual increase is greater than the natural, owing to the tendency of people to migrate from rural districts into towns for employment. The actual increment can only be ascertained by a census. It must be remembered that the rate of increase or decrease of population in any particular portion of a town cannot be considered as indicative of a similar rate for the town as a whole, as there is a growing tendency to migrate to new houses in suburbs, and consequently houses in the centre of the city, which were formerly used as residences, become merely offices, etc.

The average rate of the natural increase shows wide variations in the several countries of the world as will be seen from the attached table.

The average annual rate in England and Wales in the quinquennium, 1901-1905, was 12·1 per 1,000 of the total population. Taking this figure as a criterion, it will be seen that in proportion to total population the natural increment was above that rate in the Australian Colonies, in the Balkan States, in Russia, in the Netherlands, in the German Empire, Denmark and in Norway, while it was about equal to the English average in Scotland and below it in Austria, Hungary, Japan, Belgium, Italy, Sweden, Switzerland, Spain and the Province of Ontario. In Ireland the rate was exceptionally low, being only 5·6 per 1,000 of the population. In France the average birth-rate exceeds but slightly the average death-rate, and it is of interest to note that in six of the past nineteen years the number of deaths actually exceeded the number of births:—

Natural increase, mean annual rate of increase, by excess of births over deaths, per 1,000 living, 1881—1908.

Countries (arranged in order of rates in 1901-05.)	Quinquennial periods.					Years.		
	1881-85.	1886-90.	1891-95.	1896-1900.	1901-05.	1906.	1907.	1908.
Russia (European)	13·7	15·0	12·4	17·4	—	—	—	—
New Zealand	25·4	21·3	17·6	16·1	16·7	19·8	16·4	17·9
New South Wales	22·0	22·6	20·1	16·1	15·5	17·1	16·5	16·7
The Netherlands..	13·4	13·1	13·3	14·9	15·5	15·6	15·4	14·4
Queensland	17·3	22·5	21·7	17·1	15·3	16·7	16·5	16·5
Prussia	12·0	13·3	14·2	15·5	15·2	15·8	15·2	14·9
German Empire	11·7	12·1	13·0	14·8	14·4	14·9	14·3	—
Denmark	14·0	12·7	11·8	13·6	14·2	15·0	14·1	13·8
Norway	14.0	13·8	13·4	14·5	14·1	13·1	12·1	11·9
South Australia	23·8	22·1	19·7	15·0	13·7	13·4	14·2	15·0
Victoria	16·1	16·6	16·0	12·5	12·3	12·7	13·5	12·1
England and Wales	14·1	12·5	11·8	11·6	12·1	11·7	11·3	11·8
Austria	8·1	8·9	9·5	11·7	11·4	12·5	11·2	—
Hungary	11·5	11·6	9·9	11·5	11·0	11·2	10·8	11·5
Japan	—	7·9	7·5	10·4	10·8	9·1	12·1	—
Belgium	10·1	9·1	8·8	10·8	10·7	9·3	9·6	—
Italy..	10·7	10·3	10·5	11·1	10·7	11·1	10·8	10·8
Sweden	11·9	12·4	10·8	10·8	10·6	11·3	10·9	10·8
Switzerland	7·3	7·1	7·9	10·4	10·4	10·4	10·0	—
Spain	3·8	5·1	5·2	5·5	9·2	7·8	8·9	9·9
Chili	11·3	0·3	4·4	6·2	6·1	3·7	9·0	7·7
France	2·5	1·1	0·0	1·2	1·6	0·7	0·5	1·2

From the Annual Reports of the Sanitary Commissioner with the Government of India for 1901 *and* 1911.

Year.	Population under Registration.	Number of		Ratio (per 1,000 of population) of	
		Births.	Deaths.	Births.	Deaths.
1901 ...	224,280,118	7,760,627	6,606,387	34·60	29·46
1911 ...	238,688,119	9,209,703	7,639,544	38·58	32·01

Increase in population in different countries.

Countries.	Increase per cent. in		Intercensal Period.
	1881-1891.	1891-1901.	1901-1911.
England and Wales	11·7	12·2	10·9
Scotland...	7·8	11·1	6·4
Ireland	—9·1	—5·2	—1·7
Australia	41·1	18·9	18·1
New Zealand	27·9	23·3	30·5
Canada	11·8	11·1	34·1
India	13·2	2·5	7·1
South Africa	......	......	15·1
Germany	9·3	14·0	15·2
France	1·8	1·6	1·6
Holland	12·4	13·1	14·8
Belgium	9·9	10·6	10·9
Denmark	10·3	12·8	12·6
Sweden	4·8	7·3	7·5
Norway	10·3	12·0	6·8
Italy	......	......	6·8
United States.	25·5	20·7	21·0

Occasionally the terms *effective* and *specific* are applied to a population : the *effective population* is that between the ages of 20 and 70 ; the term *specific population* means the number of persons per acre or per square mile. This was formerly believed to be of great importance, but the significance lies really not in the number of persons per acre or per square mile so much as in the number of persons per occupied room on that area. An intercensal interval of ten years is really too long and, if accuracy of information is desired, the enumeration should occur at shorter intervals. Even then errors are liable to occur, especially in regard to age and occupation : the former may arise from real ignorance thereof or from a desire to under-estimate the real age, or from overstating the age, either from a desire for local notoriety or with the object of benefiting under any provident or national pension scheme. The returns of occupation are also misleading, as no distinction is made between employer and employee: the former may never have engaged in active work in the particular trade or, at any rate, not for many years and the inclusion of such as these tends to vitiate the returns.

Now since during the intercensal periods the population is not stationary, it is necessary to calculate the estimated population at any given date during the period. There are various methods of doing this. When the births exceed the deaths and the ratio of the births and deaths remains constant, then the population increases in regular geometrical progression. Thus, suppose the birth-rate of a population numbering 5,000 is 30 per 1,000 and the death-rate is 20 per 1,000 and that these rates remain constant for ten years, then the annual rate of increase is ten per 1,000 or 0·01 per unit, *i.e.*, one person becomes 1.01 at the end of a year or 1,000 become 1,010; thus the population at the end of the tenth year will have become 5,000 × 1·01 = 5,523 persons. For the population at the end of the first year = 5,000 × 1·01, at the end of the second it is 5,000 × 1·01 × 1·01, etc. This can be expressed in the following manner. Let P equal the population and R the ratio of annual increase, then in one year the population becomes $p \times r$ and in n years $P \times Rn$.

These calculations are more easily performed by the use of logarithms; *e.g.*, estimate the population of a town in June 1904 whose population in March 1901 was X. In order to do this, it is necessary to know the population at the previous census, *viz.*, 1891, so as to calculate the increase or decrease during the previous decade. Now to estimate the population in June 1904, *i.e.*, 3¼ years after the census, proceed as follows:—

Take the log of 1901 population and also that of the 1891 population, subtract the lesser from the greater and the result equals the log of the ten years' increase or decrease. Divide this by 10 and we get the log of the annual increase or decrease, and this divided by 4 gives the quarterly increase or decrease.

To find the population required, add to or subtract from the log. of the 1901 population (*a*) the log. for the annual increase or decrease × 3, and (2) the log. for the $\frac{1}{4}$ year's increase or decrease, and from the final log. thus obtained calculate the number corresponding, which number will be the estimated population.

It must be remembered that the official method of estimating population on the assumption of an equitable rate of increase or decrease is even approximately trustworthy in the case of very large communities only, as in such any abnormal variation in one direction is more likely to be counterbalanced by another in the opposite. In small communities, where growth is often spasmodic and irregular, such estimates cannot be relied upon. There are two unofficial methods of checking estimated populations: (1) ascertain from the rate book of the city the number of inhabited houses and, assuming the density to remain the same, then multiply the number of inhabited houses by the average number of persons per house found at the last census. This method is not so reliable now as formerly owing to the change in the customs of the people. The modern tendency to live in large hotels and flats is liable to upset calculations; as is also any alteration of the type of house, *e. g.*, when villas are replaced by cottage property. (2) A method advanced by Dr. Newsholme: assuming the birth-rate to remain the same as at the last census, then from the total number of births one can calculate the population thus, *e.g.*, the average birth-rate equals 35·68 per 1,000 and the total births equal 7,582, then the population equals 7,582 × 1,000 and divided by 35·68 equals 212,500. In this case the fallacy lies in the possible error in the estimated population for all but the census years.

REGISTRATION OF BIRTHS AND DEATHS.

An accurate registration of births and deaths is as important as an accurate estimation of the population collected at the census. Sanitary improvements depend very largely on the value of this information.

In England the Births and Deaths Registration Act of 1874 requires every birth to be registered within 42 days of its occurrence and every death within 5 days thereof.

Notification of Births Act, England 1907.

(1) In the case of every child born after the 1st day of January, 1908, it shall be the duty of the father of the child, if he is actually residing in the house where the birth takes place at the time of its occurrence, or in his absence of any person in attendance upon the mother at the time of the birth or within six hours thereafter, to send or give notice of the birth to the Medical Officer of the District in which the child is born within 48 hours after such birth.

(2) It shall be sufficient compliance with this section if notice be sent by prepaid letter or post card addressed to the Medical Officer.

(3) It shall be the duty of all the rural and urban Sanitary Authorities to bring the provisions of this Act to the attention of all medical practitioners and midwives, practising in their Districts.

(4) Any person who fails to give or send notice of a birth in accordance with this section shall be guilty of an offence and shall be liable on summary conviction to a penalty not exceeding 20 shillings.

(5) The notification required to be made under this Act shall be in addition to and not in substitution for the requirements of any Act relating to the registration of births.

(6) This section shall apply to still-born children as well as to children born alive.

In the City of Bombay Act III of 1888, as modified up to May 1912, the sections which regulate such registration are as under.

Section 442.—For the purpose of registering births and deaths the Commissioner shall divide the city into such and so many districts and sub-districts as he shall from time to time think fit and a municipal officer shall be Registrar of births and deaths of each such district.

443. (1) Every Registrar shall reside within the district of which he is Registrar and shall cause his name together with the words "Registrar of births and deaths for the district of . . ." to be affixed in some conspicuous place at or near the outer door of his place of abode; and (2) a list showing the name and place of abode of every Registrar in the city shall be kept at the municipal office and shall be open at all reasonable times to public inspection free of charge.

444. The Commisioner shall provide and supply to the Registrars a sufficient number of register books of births and of register books of deaths for the registration of the particulars specified in the Schedules M and O, respectively, and the pages of each of the said books shall be numbered progressively from the beginning to the end thereof.

Schedule N.—Particulars to be specified in the register of births are serial number, date of birth, place of birth showing district, sub-district, ward No. of house, street or *wadi*, No. of house in the street or *wadi*, names (and surnames, if any,) of parents, their occupation or profession and place of birth and duration of residence in Bombay in years, months and days; whether the mother is the only wife alive at the time of the birth or one of two wives both being alive, or one of three or more wives, all of them being alive; whether the mother was married or unmarried, whether the child was born alive or still-born, its sex, race, caste or nationality, and name (if any), the signature of the informant and the date of information given.

Schedule O.—Particulars to be specified in the register of deaths are serial number, date of death, abode showing district, sub-district, ward No. of the house, street or *wadi*, number of the house in the street or *wadi*; duration of residence in Bombay in years, months and days; if a stranger to Bombay or lately arrived, wherefrom giving village, taluka, district; name and surname, if any, sex, race, caste or nationality, age in years, months and days or still-born; occupation or profession of deceased or of his or her family; place of birth, if in Bombay, giving district, street or *wadi* and the number of the house; if out of Bombay, the village, taluka and district, country to which family belongs, cause of death, duration of disease in years, months, days and hours ; name and residence of the medical attendant ; place of disposal of the dead giving number of cemetery and whether buried, burnt or exposed.

Section 445. (1) Each Registrar shall inform himself carefully of every birth and death, which shall happen in his district and of the particulars concerning the same required to be registered according to the forms in the said schedules and shall, as soon after such birth or death as conveniently may be, register the same in a book supplied for this purpose by the Commissioner, without making any charge or demanding or receiving any fee or reward for so doing other than his remuneration as a municipal officer. (2) Other municipal officers, besides the Registrars, may be appointed with the duty of informing themselves of every birth or of every death in the district to which they are respectively appointed and of the particulars concerning the same required to be registered and of submitting such information to the Registrar of the said district or to such other person as the Commissioner directs.

446. (1) It shall be the duty of the father and mother of every child born in the city and, in default of the father and mother, of the occupier of the premises in which to his knowledge the child is born and of each person present at the birth and of the person having charge of the child to give to the best of his knowledge and belief to the Registrar or other municipal officer appointed under section 445, within seven days after such birth, information of the particulars required to be registered concerning such birth ; (2) provided that in the case of an illegitimate child no person shall as father of such child be required to give information under this Act concerning the birth of such child and the Registrar shall not enter in the register the name of any person as father of such child, unless at the joint request of the mother and of the person acknowledging himself to be the father of such child and such person shall in such case sign the register together with the mother.

447. In case any new born child is found exposed, it shall be the duty of any person finding the same, and of any person in whose charge such child may be placed to give, to the best

of his knowledge and belief, to the Registrar or other municipal officer aforesaid, within seven days after the finding of such child, such information of the particulars required to be registered concerning the birth of such child as the informant possesses.

448. (1) For every place for the disposal of the dead registered in the register kept under section 435, a municipal officer shall be appointed whose duty it shall be to receive information of the particulars required to be registered concerning the death of every person whose corpse is disposed of at such place; and (2) if the Commissioner shall not think fit to require the municipal officer so appointed to be in constant attendance at any place for the disposal of the dead for which he is so appointed, there shall be affixed to a conspicuous part of the entrance to such place a notice specifying the name of the officer so appointed for the said place and the place where he may be found.

449. (1) It shall be the duty of the nearest relatives of any person dying in the city present at the death, or in attendance during the last illness, of the deceased and, in default of such relatives, of each person present at the death, and of the occupier of the premises in which to his knowledge the death took place and, in default of the persons hereinbefore in this section mentioned, of each inmate of such premises, and of the undertaker or other person causing the corpse of the deceased person to be disposed of, to give, to the best of his knowledge and belief, to the officer appointed under the last preceding section, information of the particulars required to be registered concerning such death; and (2) the said information shall be given at or about the time that the corpse of the deceased person is disposed of, and it shall be given in writing if the informant can write, and otherwise orally, and the informant shall make known to the officer aforesaid his name, designation and place of abode, and shall attest the correctness of the information which he gives, to the best of his knowledge and belief, by his signature or mark.

450. (1) In the case of a person who has been attended in his last illness by a duly qualified medical practitioner,

that practitioner shall sign and forward to the Commissioner a certificate of the cause of such person's death in the form of Schedule P, or in such other form as shall from time to time be prescribed by the Commissioner in this behalf, and the cause of death as stated in such certificate shall be entered in the register together with the name of the certifying medical pracitioner.

(2) The Commissioner shall provide printed forms of the said certificates, and any duly qualified medical practitioner resident in the city shall be supplied, on application, with such forms, free of charge.

Schedule P.—Certificate of Cause of Death. I do hereby certify that I attended the deceased........during his last illness and that the cause of his death was, to the best of my belief,......(here state particulars) Dated....,Signed ......Medical Designation or Diploma.................

451. (1) The information concerning deaths received by every officer appointed under section 448 shall be entered by him in a register-sheet, which shall contain the particulars contained in Schedule O, and shall be forwarded, at such intervals as shall be prescribed by the Commissioner, through the Registrar of the district to the municipal office; and (2) from the said register-sheets and from the certificates furnished to him under section 450, the Commissioner shall cause the register book of deaths to be prepared and shall have prepared and published such tabular returns and statements as shall appear to him to be useful for sanitary or other purposes.

452. (1) Any clerical error which may at any time be discovered in a register of births or in a register of deaths may be corrected by any person authorised by the Commissioner in that behalf. (2) Any error of fact or substance in any such register may be corrected by any person authorised as aforesaid by entry in the margin, without any alteration of the original entry, upon production to the Commissioner, by the person requiring such alteration or error to be corrected, of a declaration on oath setting forth the nature of the error and the true facts of the case, made before a Magistrate by two credible persons having knowledge of the case.

In connection with the registration of births, the chief facts usually required are the sex, date and place of birth, the number of children, legitimacy or otherwise, and the residence, nationality or caste of the parents.

The following form illustrates the method in which a report of birth in the City and Island of Bombay has to be made.

Report of Birth in the City and Island of Bombay.

Serial Number______________

Date of Birth______________________________

Place of Birth.
- District______________________________
- Sub-District______________________________
- Ward No. of House______________________________
- Street or Wadi______________________________
- No. of House in Street or Wadi.

Parents.
- Names (and surnames, if any)______________________________
- Occupation or Profession______________________________
- Place of Birth______________________________
- Duration of residence in Bombay
  - Years__________
  - Months__________
  - Days__________

Mother being
- Only wife now alive______________________________
- One of two wives, both now alive______________________________
- One of three or more wives, all now alive__________

Mother being unmarried______________________________

Child.
- Born alive______________________________
- Still born______________________________
- Sex______________________________
- Race, Caste or Nationality______________________________
- Name, if any______________________________

Remarks—

Signature of Witness. Signature of Informant.

Date of information given :

Bombay,______________19

District Registrar's Register No.__________

District Registrar's Signature.

NOTE.—In the case of the birth of a Hindu, the particular sub-division of Caste should be given. Christians should be separated into those of pure European parentage ; those of mixed blood, *viz.*, Indo-Europeans ; and those of pure Asiatic parentage, *viz.*, Native-Christians, Negro-Africans or Siddis should be registered as such, and not as Mussalmans. In the case of Europeans their religion should be specified.

In Bombay City notification of births is compulsory, but in order to afford every facility to the general public to record such occurrences, there are working under each District Registrar of Births and Deaths, 2 Sub-Registrars and six birth *karkoons.* Each Registrar's district is equally divided, and it is the duty of these *karkoons* to make a house to house visitation in their district and ascertain if any births have occurred during the week, and any information so obtained is reported to the District Registrar who himself, or through his assistants, obtains the full details as required in the specimen form given above.

Dr. C. A. Bentley in a paper read before the second All-India Sanitary Conference, Madras (1911), described the system of registration of vital occurrences in Eastern Bengal. as follows : the system is typical of what it is elsewhere except in Presidency towns where it is regulated by law:—

"As is customary in India the village *chowkidar* is responsible for reporting vital occurrences in Eastern Bengal The beat of each *chowkidar* includes from 75 to 100 houses or *baris.* There is a *duffadar* over every 30 *chowkidars,* and the President of the *chowkidari* unions also exercises some control over them.

"The chowkidars are supposed to visit every house in their beat at intervals : once a week, or once a fortnight in the case of outlying districts, they attend the *chowkidari* parade at the *thana* police station ; and they give in their reports of vital occurrences on this occasion.

"The pay received by *chowkidars* is so low that they are obliged to add to their income in other ways, and they usually hold and cultivate land. It is also not an uncommon occurrence to find a *chowkidar* whose own house is in a village some miles from his legitimate beat. Under these circumstances there is no certainty of the men visiting the different portions of their beats with any regularity ; and in many cases they appear to rely upon gaining their knowledge of births and deaths by inquiry among the villagers who attend the weekly *bazars.* As it is an exception for a *chowkidar* to be literate, the entries in their *háthchitiás* are usually made by the *duffadar* or *panchayat* or in some cases at the *thana* police station itself. Many of the men too are comparatively aged and have impaired memories for recent events. Some *chowkidars* have been met with who were unable to remember if a birth or death occurred in their beat during the preceding week, fortnight or month. This being so, there is little chance of the returns of vital occurrences being accurate. During the investigation, it was found that omissions on the part of the *chowkidars* to record births numbered about 6 per cent. of the whole, and about 4 per cent. of deaths were not recorded. These figures, however, give a false impression, because at the beginning of the inquiry a much larger proportion of omissions were detected. But later on the *chowkidars* became much more careful in their reporting and many deaths and births which they had at first failed to note were subsequently recorded by them, sometimes a very long time after they had occurred.

"There are other grounds also for believing that ordinarily a much larger percentage of omissions occur in the registration of the births and deaths. The more ignorant and superstitious among the villagers have a great dread of reporting the occurrence of a birth, as they fear that their doing so may lead to the death of the child; and they will often actually deny that a birth has occurred, especially when a death has recently taken place among the family. The analysis of the age-periods at which deaths occur shows that frequently almost as many deaths are recorded among children aged 1-5 years as among infants. These facts suggest the possibility of many births and deaths of young infants going unreported.

"As regards the classification of the causes of death, the investigation shows that in the district examined the only returns of any value are those relating to Cholera and Smallpox. The heading "Fever," as is well known, is absolutely misleading and about as useful as that of "all other causes." But this is not entirely the fault of the village *chowkidar*. His own reports are frequently much more informing than those that eventually filter through to the authorities; and with a little trouble might be made exceedingly valuable.

There are commonly understood terms for many easily recognised diseases current among the villagers in every district; and until driven into the routine method of reporting deaths as due to "Fever," "Cholera" or "Small-pox," the *chowkidars* make frequent use of them. Sudden deaths are often reported as "*thabra*" or "*thapti mara,*" literally "a sudden blow;" Tetanus Resnatorium as *pachoa paoa*, literally attacked by a ghost; and Measles, Phthisis and Pneumonia are often indicated by special names, such as *bappi, koi,* and *bath sleshwar.* But when the *daroga* or writer constable at the *thana* police station receives such reports, they usually go down in his register under the heading "other causes," merely because such terms are not used in the schedule.

"Observations made during the course of the investigation appear to show that it would be possible to improve the existing system of registration without great difficulty. Under the existing system all vital occurrences are pooled at the *thana* police station and the Civil Surgeon or other district officials cannot get detailed information without special inquiry; even then, it is not an easy matter to get accurate figures for the various unions, and it is still more difficult to get figures for individual villages.

"But if a register were kept in which each union in a *thana* was given an initial A. B. C., etc., and each *chowkidari* beat in the union was assigned a number A-1, A-2, A-3, etc., and all entries were recorded by beats and unions, it would be possible to immediately locate peculiarities in the returns especially high or excessively low mortalities. As the numbers of houses in each beat are known, it would be a very simple matter to gauge from this register the approximate mortality rate of every portion of a *thana.*

"By collecting for each district the current names in common use for a number of diseases, inserting them in the vernacular schedules, and giving special instructions that the *chowkidars* should be ordered to report all deaths from these causes, it would be possible also to greatly increase the value of the present returns.

"It is possible, however, that a scheme for keeping special registers in each union, utilizing the services of the *panchayats*, village *patwaris* (where they exist) or village schoolmasters, for the purpose might give good results. Village schoolmasters are particularly well placed for obtaining information regarding vital occurrences independently of the reports of *chowkidars*, so that they could easily exercise a check upon the registration of vital occurrences; and in connection with the attempt to teach elementary hygiene in the schools it might be a useful measure to interest them in such matters.

"Finally, the importance of more careful registration of the total number of deaths occurring must be strongly emphasized. Each year sees an increasing demand for an extension of measures of sanitation but, in the absence of accurate recording of vital occurrences, there is a grave danger that, instead of finding improved sanitation result in a diminished death-rate, we shall actually see an apparent increase of mortality taking place. In the case of Municipalities in Eastern Bengal, death registration is a mere farce. In Chittagong town, an investigation in 1911 showed that 35 per cent. of the deaths went unrecorded; and in Dinajpur town, in 1912, inquiry has shown that 40 per cent. of the deaths occurring during the first six months were not reported. In the face of the facts, it would appear that improved registration both for urban and rural communities is the most urgent of all sanitary reforms."

BIRTH-RATES.

The birth-rate is obtained by comparing the total number of births in a year and the total estimated population at the middle of the same year and is represented as the rate per 1,000 of the population living in the district at all ages and of both sexes. To obtain it, multiply the total number of births by 1,000 and divide by the population at the middle of the year.

As pointed out by Newsholme, it would be better if it were calculated as a proportion of births to the women living at child-bearing age (15-45), the number of whom could be obtained from the census. This method, which is expressed as one birth per so many women, enables more accurate comparisons to be made between one country and another than the first method which gives what is known as the crude birth-rate. The births registered in the United Kingdom in the year 1908 numbered 1,173,759 and were in the proportion of 26·3 per 1,000 of the population at all ages. This rate was 0·3 per 1,000 above the corresponding rate in 1907. Compared with the average in the ten years 1898-1907, the birth-rate in 1908 showed a decrease of 1·4 per cent.—

Countries.	Total Births in the year 1908.	Birth-Rate per 1,000 living		Births.		Birth-Rate per 1,000 living.	
		1898-1907.	1908.	1909.	1910.	1909.	1910.
England and Wales.	940,383	28·1	26·5	914,472	896,962	25·6	25·1
Scotland	131,337	28·9	27·2	128,582	124,000	26·4	26·2
Ireland	102,039	23·2	23·2	102,759	101,963	23·5	23·3
Total ..	1,173,759	27·7	26·3	11,45,813	1,122,925	25·5	25·0

In Great Britain in the year 1876 the birth-rate attained the highest point on record, *viz.*, 36·3 per cent.; since this date the rate has fallen year by year with a few insignificant exceptions, until in the year 1907 it was only 26·3 per 1,000. Although the slight rise in the crude birth-rate to 26·5 in 1908 is noteworthy, it is probably only a reflection of the upward tendency in the marriage-rate which took place in the years 1905-1907.

The birth-rate is higher in towns, because there is a higher marriage-rate and women marry at an earlier age and moreover there is a greater infantile mortality. Further, urban districts have a greater proportion of women of marriageable age One of the main factors determining the birth-rate should be the marriage-rate, not the marriage-rate of the same or even of the next preceding year, but the combined rates of several years. Commercial prosperity increases the birth-rate, owing to an increased number of marriages. The birth-rate is high in mining districts and large industrial centres ; and, as a rule, it is high among the poor. As we have seen, the birth-rate in England is falling, and there is at present no indication of any real check in the decline; but this decline is not confined by any means to England alone; it is a feature common to nearly all European countries and also to the principal Colonial States. The following table demonstrates this point clearly:—

Annual Birth-Rate per 1,000 *persons living,* 1881-1908.

Countries (arranged in order of rates in 1901-05.)	Quinquennial Periods.					Years.		
	1881-1885.	1886-1890.	1891-1895.	1896-1900.	1901-1905.	1906.	1907.	1908.
Russia, European	49·1	48·2	48·2	49·3	—	—	—	—
Ceylon	—	30·3	31·7	37·2	38·8	35·7	32·8	40·1
Hungary	44·6	43·7	41·7	39·4	37·2	36·0	36·0	36·3
Chili	39·1	35·5	37·0	35·0	36·1	36·6	38·6	39·3
Austria	38·2	37·8	37·4	37·3	35·6	34·9	33·8	—
Spain	36·4	36·0	35·3	34·3	35·0	33·4	32·9	33·2
Prussia	37·4	37·3	37·0	36·5	34·8	33·7	33·0	32·8
German Empire	37·0	36·5	36·3	36·0	34·3	33·1	32·3	—
Italy	38·0	37·5	36·0	34·0	32·6	31·9	31·5	33·4
Japan	—	28·5	28·6	31·1	31·7	28·9	33·0	—
Norway	31·2	30·8	30·2	30.1	28·6	26·7	26·3	26·2
England and Wales	33·3	31·4	30·5	29·3	28·1	27·1	26-3	26·5
Switzerland	28·6	27·5	27·7	28·5	28·1	27·4	26·8	—
Belgium	30·7	29·3	28·9	28·9	27·7	25·7	25·3	—
New South Wales.	37·7	36·4	32.9	28·0	26·7	27·0	27·1	26·8
France	24·7	23·1	22·3	21·9	21·2	20·6	19·7	20·2
Bombav City	19·8	20·2	18·7	14·4	22·2	21-2	19·9	20·6

Apart from fluctuations in the marriage-rate, there are other factors at work tending to a decrease in the birth-rate, chief amongst which is the deliberate prevention of conception. The effect of the fall of the birth-rate on the growth of the population has been, to some extent, modified by the concurrent fall in the death-rate, but obviously this fall in the death-rate cannot continue indefinitely, and, other factors being equal, the results of the next census will show a further reduction in the proportion of children in the population. The proportion of male to female children born is as 104 to 100, but before the end of the second year the figures approximate owing to the greater mortality among male infants. There is a greater tendency towards male births in large families and among the early born than the late born.

Amongst other causes of the decreased birth-rate must be reckoned the general tendency towards postponement of marriage to a later age and the diseases of sex which appear as a concomittant to postponed marriages. Again, there is a definite diminution of desire for offspring, because of competing pleasures and of increased strain of the struggle for existence, resulting in an increase of mental and nervous diseases in general.

The illegitimate birth-rate is usually reckoned in the same way as the birth-rate, *i. e.*, as a proportion to every 1,000 persons living. It is occasionally stated as a proportion to the total births, but this is misleading, as the total number of births varies as the marriage-rate, and this is greatly dependent on the activity of trade; consequently, if trade is depressed, the marriage-rate is low and the proportion of illegitimate births appears unduly high. A more accurate method would be to reckon illegitimate births as a proportion to every 1,000 unmarried women at child-bearing age, *viz.*, 15 to 45. The illegitimate rate varies in different countries and districts thereof. The following table summarises the illegitimate birth-rate of a few of the principal countries of the world :—

Illegitimate Birth-Rates.

Countries (arranged in order of rates in 1900-02.)	Proportion of Illegitimate Births per 1,000 unmarried and widowed women aged 15-45 years.			Increase (+) or Decrease (—) per cent. in illegitimacy during 20 years.
	Approximate Periods			
	1880-82	1890-92	1900-02.	
Austria	43·4	42·7	40·1	— 7·6
German Empire	29·6	28·7	27·4	— 7·4
Sweden	22·6	22·9	24·3	+ 7·5
Denmark	26·9	24·5	24·2	— 10·0
Prussia	25·8	25·1	23·7	— 8·1
Italy	25·4	...	19·4	— 23·6
France	17·6	17·7	19·1	+ 8·5
Belgium	20·0	20·6	17·8	— 11·0
Norway	19·7	16·9	17·2	— 12·7
Spain	16·0	17·5	15·5	— 3·1
Scotland	21·4	17·1	13·4	— 37·4
Australian Commonwealth	14·5	15·9	13·2	— 9·0
Switzerland	10·8	10·0	9·8	— 9·3
New Zealand	13·4	9·0	8·9	— 33·6
England and Wales	14·1	10·5	8·5	— 39·7
The Netherlands	9·7	9·0	6·8	— 29·9
Ireland	4·4	3·9	3·8	— 13·6

There is probably no single explanation of the wide variations in the rates of illegitimacy, but differences of religion, of social conditions, of race and of the marriage laws, particularly in regard to the possibility of legitimization by subsequent marriage, must all be taken into account.

MARRIAGE-RATES.

The crude marriage-rate can be obtained, like the birth-rate, as the proportion of persons marrying per 1,000 of the population living in the middle of the year. This rate is useful for comparing the rates of marriage in a population from year to year, but it is not adapted for comparisons extending over a long series of years, because it takes no account of the effects of changing constitution of a population, nor is it well adapted for comparing the rates in two or more communities, because of the difference in the sex and age constitution of the respective populations. In view of this changing constitution, a better method of measuring the rate would be to eliminate the married persons and young children and to calculate the rate on the unmarried and widowed portion of the population, aged 15 and upwards, so dealing with that section of the population only in which marriages take place. A still more precise method would be to take account not only of the changes in the proportion of marriageable persons, but also of the changes in their ages. A difficulty, however, arises in attempting to make such a calculation owing to the comparatively high proportion of unstated ages in the marriages of earlier years. On the assumption, however, that an approximation to the number of marriages in each group may be obtained by distributing the unrecorded ages in the same proportion as the recorded, a rate has been calculated by the Registrar-General for the period of 1876-1880, based on the age constitution and proportion of marriageable persons, women in the census 1901. Taking this corrected rate as a standard, the marriage-rate in 1908 when compared with the rate for 1876-1880 shows a fall of 15·4 per cent.

The marriages in the United Kingdom during the year 1908 numbered 319,257 corresponding to the rate of 14·3 persons per 1,000 of the population at all ages. This rate was 0·8 per 1,000 below the corresponding rate in 1907 and 0·7 below the average rate for the ten years 1898-1907.

The following table affords the means of comparing the marriage-rates in several countries in various parts of the world. Some of the disparities between the rates are due to differences in the age constitution of the several countries; perhaps also to differences in the facilities afforded for marriages by the laws and customs of the different countries and states—

Countries.	Marriages.	Persons married per 1,000 living.			
	1908.	1898-1907.	1908.	1909.	1910.
England and Wales ...	264,940	15·8	14·9	14·6	15·0
Scotland...	31,583	14·2	13·1	12·3	13·0
Ireland	22,734	10·2	10·4	10·4	10·1
United Kingdom ..	319,257	15·0	14·3	13·9	14·3

It will be seen that, whereas of the 13 states which in the period 1901-1905 had a higher rate than England and Wales, only Spain and Austria failed to maintain their position in the more recent years and no fewer than five of the sixteen States in the lower part of the table, *viz.*, France, Tasmania, Italy, New South Wales and South Australia, had in 1908 marriage-rates above that recorded in England and Wales.

Annual Marriage-rates per 1,000 *persons living*, 1881-1908.

Countries (arranged in order of rates in 1901-5.)	Quinquennial Periods.					Years.		
	1881-1885	1886-1890	1891-1895.	1896-1900.	1901-1905.	1906.	1907.	1908.
Russia (European)..	18·0	17·1	17·9	17·8	..	..	..	..
Hungary	20·4	17·8	18·0	17·0	17·2	17·4	19·6	18·2
Japan	..	16·6	17·0	18·1	16·3	14·6	17·7	..
New Zealand	13·6	12·0	12·2	14·2	16·3	17·0	17·0	18·0
Belgium	13·7	14·2	15·1	16·6	16·1	16·1	16·0	..
German Empire	15·4	15·8	15·9	16·8	16·1	16·3	16·3	..
Prussia	15·9	16·2	16·1	16·9	16·1	16·4	16·4	16·1
Spain	12·6	13·3	16·2	15·3	16·0	14·1	13·9	14·3
Austria	15·8	15·5	15·8	16·2	15·7	15·8	15·0	..
England and Wales	15·2	14·7	15·1	16·1	15·6	15·6	15·8	14·9
France	15·0	14 4	15·0	15·1	15·3	15·6	16·0	16·1
Switzerland	13·7	14·1	14·5	15·5	15·0	15·6	15·6	..
Italy	16·1	15·5	14·8	14 3	14·7	15·5	15·4	16·6
New South Wales	17·0	14·9	13·3	13·9	14·7	15·3	15·7	15·9
Denmark	15·4	14·0	13·9	15·0	14·3	14·0	15·3	14·8
Victoria	14·7	16·3	12·9	13·3	13·7	14·6	15·4	14·8
South Australia	16·9	13·5	12·9	12·5	13·3	14·2	15·9	15·8
Norway	13·4	12·8	12·9	13·7	12·3	11·8	12·1	12·2
Sweden	12·8	12·2	11·5	12·2	11·8	12·3	12·4	12·2
Chili	12·6	7·4	9·2	9·3	10·3	11·4	13·0	13·0

The marriage-rate is always higher in towns than in rural districts, because a number of young country people go to the towns for work and there marry. Moreover, in towns there is always an excess of young people of marriageable age. Trade also influences the number of marriages: if good, the number increases. The increased competition in life, the higher standard of living and education, and the desire for personal comfort, in combination with the increased price of many of the necessities of life, have all exercised their influence in bringing about a decline in the marriage-rate. Not only has there been a decline in the rate but the average age of marriage is gradually rising. This is reflected in the fecundity of the marriage, as this is influenced by age, especially the age of the wife. Since 1873 the mean age at marriage has gradually risen in England. The age of maximum fecundity is for men 25-26 and for women 18-19. In England the average number of children per marriage is 4·5.

In India the marriage-rate based on the number of persons married to the *total population returning civil conditions* was 474·7 per 1,000 of persons according to the census of 1891 and 464·7 according to that of 1901.

DEATH-RATES.

The death-rate may be expressed either as a proportion to every 1,000 of the mean population, or as one death per so many living. In order to obtain the general or gross death-rate (annual), it is necessary to multiply the number of deaths by one thousand and divide by the population at the middle of the year, *e.g.*, if the population be 20,000 and the deaths during the year amount to 400, then $\frac{400 \times 1,000}{20,000} = 20$ per 1,000. When the returns are required for a shorter period than one year, a different method has to be adopted: one may desire weekly or monthly rates; and these rates represent the number of deaths that would take place per 1,000 of the population in a year, if the proportion of deaths to the recorded population in these shorter periods were maintained throughout the year. The correct number of days in a year is 365·24,226 and of weeks is 52·17,747. The birth-rate or death-rate may be accurately calculated from weekly, monthly and quarterly returns as follows :—To estimate *weekly* rates :—

$$\frac{\text{number } \textit{of deaths during the week} \times 52.17{,}747 \times 1{,}000}{\text{Population}}.$$

Monthly rates are obtained thus :—

$$\frac{\textit{Number of deaths in 4 weeks} \times 13 \times 1{,}000}{\text{Population}}.$$

Quarterly rates thus :—

$$\frac{\textit{Number of deaths in the quarter} \times 4 \times 1{,}000}{\text{Population}}.$$

There is another way in which these rates can be arrived at.

First ascertain what may be called the 30 or 31 days population of the town or district in this manner, *e.g.*, the population equals 643,148=Log.5.8083109. The number of days in a month equals 31=Log.1.4913617 and the number of days in a year 365=Log. 2.5622929 then—

$$\frac{\textit{The population} \times \textit{the number of days in a month under consideration}}{365}$$

equals the 31 days population, equals Log. 4.7373797. Now the death-rate equals

$$\frac{\text{the deaths} \times 1{,}000}{\text{Population}};$$

therefore, if in the above example the deaths were 785, then

$$\frac{785 \times 1{,}000}{\text{Population}} \text{ equals } \frac{\text{Log. } 5.8958697}{\text{Log. } 4{\cdot}7373797} \text{ equals Log. } 1{\cdot}1574900 = 14.37$$

the death-rate.

The deaths registered in the United Kingdom in the year 1908 numbered 675,186 and were in the proportion of 15·1 per 1,000 of the population at all ages. This rate was 0·3 per 1,000 below the corresponding rate in 1907, and compared with the average in the period

1898-1907, the death-rate in 1908 shows a decrease of 1·6 per 1,000.

Countries.	Deaths.	Death-Rates.			
	1908.	1898-1907	1908.	1909.	1910.
England and Wales	520,456	16·4	14·7	14·5	13·5
Scotland	77,839	17·1	16·1	15·3	15·3
Ireland	76,891	17·8	17·6	17·2	17·1
United Kingdom	675,186	16·7	15·1	14·8	14·0
		(1903-1907)			
India	8,653,007	33·96	38·22	30·91	33·20
Bombay Presidency	5,01,838	39·64	27·15	27·38	30·30
Bombay City	38,271	54·27	39·13	35·66	35·72

The following table gives the crude annual death-rates per 1,000 living, in the countries mentioned, in the period 1881-1908:—

Countries (arranged in order of rates in 1901-05.	Quinquennial Periods.					Years.		
	1881-1885.	1886-1890.	1891-1895.	1896-1900.	1901-1905.	1906.	1907.	1908.
Russia (European)	35·4	33·2	35·8	31·9	..	..	..	..
Ceylon	...	25·1	28·3	27·0	26·7	34·3	30·1	29·4
Hungary	33·1	32·1	31·8	27·9	26·2	24·8	25·2	24·8
Spain	32·6	30·9	30·1	28·8	25·8	25·6	24·0	23·3
Austria	30·1	28·9	27·9	25·6	24·2	22·4	22·6	..
Italy	27·3	27·2	25·5	22·9	21·9	20·8	20·7	22·6
Japan	..	20·6	21·1	20·7	20·9	19·8	20·9	...
German Empire	25·3	24·4	23·3	21·2	19·9	18·2	18·0	..
France	22·2	22·0	22·3	20·7	19·6	19·9	20·2	19·0
Prussia	25·4	24·0	22·8	21·0	19·6	17·9	17·8	17·9
Switzerland	21·3	20·4	19·8	18·1	17·7	17·0	16·8	..
Belgium	20·6	20·2	20·1	18·1	17·0	16·4	15·7	..
England and Wales	19·4	18·9	18·7	17·7	16·0	15·4	15·0	14·7
Sweden	17·5	16·4	16·6	16·1	15·5	14·4	14·6	14·9
Norway	17·2	17·0	16·8	15·6	14·5	13·6	14·2	14·3
Victoria	14·7	16·1	14·0	13·7	12·7	12·4	11·7	12·5
Western Australia	17·1	16·0	16·3	15·1	12·4	11·8	11·1	10·7
Queensland	19·2	14·9	12·4	12·0	11·4	9·6	10·6	10·1
New South Wales	15·7	13·8	12·8	11·9	11·2	9·9	10·6	10·1
South Australia	14·7	12·6	12·3	12·0	10·8	10·3	9·7	9·7
New Zealand	10·9	9·9	10·1	9·6	9·9	9·3	10·9	9·5
Bombay City	28·5	27·6	30·6	65·4	64·1	54·07	39·56	39·13

Now these gross or crude death-rates have to be subjected to correction according to the age and sex distribution of the population, and also for non-resident or migratory persons. Correction for age is necessitated, because the death-rates for the age-periods between 5 and 55 are lower than those for ages below 5 and above 55. If therefore in any district there is, compared with some other district, an excess of population between 5 and 55, there will be a lower death-rate, because of this greater liability to death at the two extremes of life ; this liability reaches a minimum at the 10-15 age-period and thereafter rises steadily throughout life. In many towns there is a considerable immigration of young adults seeking employment and, moreover, most towns contain a smaller proportion of people of great age, as many of them retire to the country to spend their later days. Correction for sex is necessary because, as a class, females live longer than males, the death-rate among the latter being uniformly higher except at ages 10 to 20. In many towns, especially seaside and watering places in England, there is a large influx of young adult women of the servant and waiting-maid class, among whom the liability to death is comparatively small. These facts tend therefore to lessen the true death-rate of the place and, to allow for this and obtain a more correct death-rate, the Registrar-General of England devised a method by which the recorded gross or crude death-rate of the large cities and towns of England and Scotland could be made comparable to that of England and Wales generally. This new rate is known as the corrected death-rate. The method consists in estimating a series of factors by which the recorded rate is multiplied, resulting in a raising or lowering of that rate to what it would be if the age and sex population of that particular town were the same as in England and Wales as a whole. Owing to the proportion of persons of low mortality (young adults and females) being excessive in most towns, their recorded death-rate is too low and consequently their factor is above unity and therefore their recorded death-rate reads at a lower figure than the corrected. Corrections are also made for non-resident persons. As a general rule, deaths in large public institutions, such as asylums, prisons, hospitals, work-houses, etc., are relegated to the district from which the individual came. To do otherwise would result in unfairly raising the death-rate of a town in which one or more of these institutions happened to be located.

In India no factors exist for age and sex correction, and the term corrected death-rate as applied to the Bombay City statistics is merely indicative of the fact that all deaths of individuals, whose residence in the City has not exceeded 10 days, have been excluded.

There are certain other terms applied to death-rates to which it is necessary to refer.

Combined Death-rate.—By this is understood the mean death-rate of two populations, perhaps adjoining; the estimation thereof is a frequent source of error to students, usually arising from failure to take into consideration the proportion which the two populations bear to one another, *e.g.*, if two towns were of equal population, say 30,000, and the death-rate of one was 22 and of the other 16, then the combined death-rate is $\frac{22+16}{2}=19$ per 1,000; but if the towns have a dissimilar population, *e. g.*, 42,000 and 18,000 and the respective mortalities were 22 and 16, then A with 42,000 population and a death-rate of 22=924 deaths, and B with 18,000 population and a death-rate of 16 gives 288 deaths: that is to say, the combined populations *viz.*, 60,000 gave 1,212 deaths, then $\frac{1{,}212+1{,}000}{60{,}000}=20.2$, the true combined death-rate.

Infantile Death-Rates.

The infantile mortality is occasionally stated as a proportion per 1,000 of the general population, or again, as a proportion to the total number of deaths. The most usual method adopted, however, is that which states it as a proportion of deaths of infants under one year of age to the total number of births registered during the year. It is obtained by multiplying the actual number of deaths of infants under one year by 1,000 and dividing by the number of births during the year. In England and Wales, in the year 1908, there were 113,254 deaths among infants giving a death-rate of 120 per 1,000, which rate is 22 per 1,000 below the average for the decennium 1898-1907. In the period 1871-1880 it was 149 per 1,000 and in the year 1885 the rate was 138. In 1909, 99,430 deaths occurred among infants giving a mortality-rate of 109 per 1,000 births. In 1910 there were 94,579 deaths among infants, giving a mortality-rate of 105 per 1,000 births. In 1911 the number of infantile deaths was 94,579, giving a death-rate of 130 per 1,000 births.

If the records for a long series of years be examined, it will be found that the mortality rates are subject to wide fluctuations and that these are most marked in the third quarter of the year when epidemic Diarrhœa becomes most prevalent. This excessive rise has been shown to be associated with a high summer temperature, especially when accompanied by deficient rainfall. Recent investigations tend to show that there is some association also with the increase in the number of the domestic house fly.

As a rule the infantile mortality is lowest in a purely agricultural district and highest in mining centres and towns associated with large textile works.

Table showing infantile mortality in urban and rural groups :—

England and Wales.

Cause of Death.	Ratio of urban to rural mortality, the latter being taken as 100.			
	Under 3 months.	3-6 Months.	6-12 Months	Under one year.
All Causes	114	152	156	130
Whooping Cough ...	72	87	90	85
Diarrhœal Diseases ...	221	263	305	263
Premature Births ...	104	179*	67*	105
Congenital Defects ...	118	119	78	115
Atrophy, Debility, Marasmus	97	129	167	106
Tuberculous Diseases ...	156	166	153	158
Convulsions	109	101	88	104
Bronchitis and Pneumonia	122	149	150	140

* These rates are of little significance owing to the paucity of the data on which they are founded.

Bombay City.

The following table gives the *crude* infantile death-rate in Bombay City during the period 1901-1912 :—

Year.	Rate.	Year.	Rate.	Year.	Rate.
1901	574·5	1905	557·1	1909	404·7
1902	542·8	1906	534·7	1910	413·9
1903	522·8	1907	423·6	1911	379·8
1904	489·2	1908	450·1	1912	448·2

It is necessary to point out, however, that serious as the infantile death-rate is in Bombay, it is not so excessive as the above rates would appear to indicate. This is due to the fact that, although all deaths are accurately known and registered, the same standard of registration does not obtain in respect of births, owing to obvious differences in the sources of information and the secretive habits of the people in regard to births.

The subject of infant mortality has, of late years, greatly attracted the attention of the public health authorities and others interested in the waste of infant life.

In the report for 1910 on the Public Health of Bombay, great stress was laid on the fact that the figures are fallacious, because the number of infants dying during the year under the age of 1 year, calculated on the number of births registered, is incorrect, as many of the infants dying were not registered as born.

In the Annual Report of the Registrar-General, England and Wales, it is seen how the birth-rate is measured and it is necessary to adopt that system to explain the necessary correction in Bombay.

Among the several factors affecting the birth-rate, note must be taken of the changes in the women of conceptive ages in the population, and of the changes in the age constitution of the married female population ; as also of the custom prevailing in Bombay for pregnant women to leave the City and return with a child 2 or 3 months old.

The crude birth-rate, *i.e.*, the proportion of registered births to the total population at all ages, is sufficient for comparing the birth-rate in a population from year to year in other countries : but in India many corrections must be made.

While in conjunction with the death-rate it generally affords a ready means for gauging the natural increase in a population, in India again this would be a fallacy, as the crude birth-rate is not adapted for comparison over a long series of years, because it takes no account of the effect of the changing constitution of a population in regard to age, sex, condition or marriage. It is desirable, therefore, to make a comparison of birth-rate, based not only on the total population but also on the number of possible mothers.

How these corrections have to be made is seen by comparing the following statement :—

Place.	Population by Census.	Proportion per cent. of women between 15-45 years in the total population of both sexes and all ages.	Proportion per cent. of married women in the female population between 15-45 years.	Proportion per cent. of married women between 15-45 years in different age groups.				Persons married to 1,000 marriageable persons in the population.	Birth-rate calculated per 1,000 of population at all ages.	Birth-rate calculated per 1,000 of female population 15-45 years.
				15-20	20-25	25-35	35-45			
England & Wales.	3,49,45,600	25·0	46·8	·7	11·8	46·8	40·7	48·6	26·3	105·1
Glasgow	8,47,584	..	..	..	..	..	..	..	..	114·8
Bombay	9,77,822	22·6	77·0	76·4	85·9	80·9	58·5	73·8	20·6*	143·5

* Counted by adding children born out of Bombay of women belonging thereto, 32·4.

In order to get at a true statement it would be necessary to include all those children who are born out of Bombay, of mothers belonging to the City, and brought to Bombay after birth.

During 1912, 6,577 of such children under 1 year of age were primarily vaccinated in Bombay, but a large number must have escaped vaccination either by death or postponement. From the vaccination returns it is seen that 78·27 per cent. of the births registered were vaccinated during the year ; it may therefore be assumed that 78·27 per cent. of the unregistered children also were vaccinated : the balance of 21·73 per cent. having escaped vaccination either by death or postponement.

Thus the infant population in the City during 1912 works out as follows :—

Number of births registered	21,518
Number of births unregistered (of children primarily vaccinated in Bombay)	6,577
Number of births unregistered and which escaped vaccination (being 21·73 per cent.) ..	1,825
Total number of births	29,920

giving the birth-rate of 30·44 per 1,000 of population compared with 38·58, the birth-rate for the whole of India.

That this is not over-estimating the figure is borne out by the table given above, from which it will be seen that while in England the birth-rate per cent. of females between 15 to 45 years of age is 10·5, in Bombay it is 14·3, and in Glasgow it is 11·4 ; while the percentage of child-bearing women between the ages of 15 and 45 to the total female population is 77·6 in Bombay, it is 46 in England ; while the percentage of married women between the ages of 15 to 20 in Bombay is 76·4 compared with ·7 in England.

The birth-rate stated in terms of the total population (crude birth-rate) must, however, obviously vary with the proportion of females of conceptive ages in the population and with the age constitution of the married female population. Hence the comparison of birth-rate should be based not only on the total number of population but also on the number of possible mothers.

These variations as revealed by the census of 1911 are shown in the following statement :—

Census year.	Proportion per cent. of women aged 15-45 years in the total population of both sexes and all ages.	Proportion per cent. of married women in female population aged 15-45 years.	Of the married women aged 15—45 years, the proportion per cent. of four groups of ages.				Persons married to 1,000 marriageable persons in the population.	Birth-rate calculated		
			Aged 15—20 years.	Aged 20—25 years.	Aged 25—35 years.	Aged 35—45 years.		On the number of births registered in the year.	Per 1,000 of total population at all ages.	Per 1,000 of female population aged 15—45 years.
1901	22·05	77·08	18·55	25·60	39·35	16·49	714·34	1901	17·42	79·00
1906	22·61	77·04	17·62	27·69	39·89	14·77	738·45	1906	21·24	93·93
1911	21·28	76·75	18·25	27·30	39·69	14·75	716·75	1912	21·96	103·19

Besides the factors which influence in common the birth-rate of every community there are some peculiar to Bombay :—(1) the fairly well-established custom of sending prospective mothers home to their parents, where the baby has a better chance of life, so that there is in the City a number of children of mothers belonging to the City but born outside it, and therefore not registered ; (2) the ommission of parents or relatives to register births, through ignorance or neglect, so that there is a considerable number of children who have escaped registration.

The infant mortality then should be calculated on the corrected number of births, which in 1912 would be 29,920, giving an infant mortality of 322·3 per 1,000 of the births compared with 228·3 per 1,000 for the whole of India, which, although very high, is not an unreasonable difference for a large city and is much nearer the truth than when calculated only on the number of births registered during the year.

The inquiries into the causes of death of infants under one year and the mortality due to puerperal diseases are continued from year to year in Bombay.

The following tables show the number of births registered in this city during the four years 1909, 1910, 1911, 1912 and also the various causes of death in infants under one year of age. The percentages of deaths under various diseases shown in the tables are calculated on the total number of deaths under 1 year of age.

The following statement tabulates the work of the Municipal Nurses and Midwives in regard to attendance at birth and infant visitations. It is their duty to find out and advise prospective mothers as well as attend on confinements, and repeat their visits during and after the lying-in period; to find out, as far as possible, and warn against the pre-natal and post-natal influences adverse to infant life :—

Summary of inquiries and of work of Municipal Nurses and Midwives.	1909.	1910.	1911.	1912.
Total number of births (including still-born) registered	21,645	21,505	23,135	23,186
Percentage of still-births to the total number of births registered	8·34	7·28	7·60	7·19
Number verified by the Nurses	13,677	12,762	13,578	14,417
Percentage of the number verified to the total ..	63·1	59·3	58·7	62·1
Do. confinements unattended ..	18·0	15·2	12·7	13·0
Do. do. attended by unskilled women..	58·3	59·6	60·7	59·6
Do. do. attended by qualified Nurses (including Municipal) ..	11·3	12·0	13·2	13·9
Do. of the confinements attended by the Municipal Nurses	4·5	5·6	5·5	6·6
Do. children born in Hospitals ..	12·3	13·2	13·2	13·5
Do. do. born in healthy condition	67·8	68·9	74·9	73·75
Do. do. fed on breast	64·9	59·8	69·7	66·5
Do. do. dying within 30 days..	12·3	11·8	11·5	11·8
Do. cases where the mothers left home for work..	31·3	27·9	34·4	29·7

Table of Deaths among Infants from principal causes by age-periods, in 1911 *and* 1912 *in Bombay City.*

Age-period.	Year.	Small-pox.	Measles.	Malaria.	Ague and Remittent Fever.	Diarrhœa and Dysentery.	Premature Birth.	Debility.	Nervous System.	Respiratory System.	All Causes.	Percentage of deaths in each age-period to total deaths under 1 year of age
1 to 30 days ...	1912	10	..	..	20	51	218	2,152	347	70	2,937	30·44
	1911	4	1	1	51	45	173	2,086	340	63	2,815	34·66
1 to 6 months ..	1912	121	17	7	83	258	1	354	903	1,247	3,188	33·04
	1911	39	37	2	93	171	2	224	743	932	2,426	29·87
7 to 12 months ..	1912	143	64	17	145	591	..	75	320	1,560	3,521	36·50
	1911	55	195	6	97	365	..	54	317	1,369	2,879	35·45
Total..	1912	274	82	24	248	900	219	2,581	1,570	2,377	9,646	..
	1911	98	233	9	241	581	175	2,364	1,400	2,364	8,120	..

The next table shows the percentage of deaths in each age-period to total deaths under one year of age for the years 1911 and 1912 (all causes included) :—

Age-period	Bombay.		Glasgow.
	1911.	1912.	1911.
1 to 30 days	34·66	30·44	31·99
1 to 6 months	29·87	33·04	35·69
7 to 12 months	35·45	36·50	32·30

The study of the subject may be pursued with the help of the next table which shows the percentage or proportion of mortality under each cause of death to the total mortality from all causes among infants in each age-group :—

Table of Percentages of Infant deaths from principal causes in 1912 in Bombay :—

Age-period.	Small-pox.	Measles.	Malaria.	Ague and Remitent Fever.	Diarhœa and Dysentery.	Premature Birth.	Debility.	Nervous System.	Respiratory System.	All Causes.
1 to 30 days ..	·34	·03	..	·68	1.73	7·42	73·27	11·81	2·38	30·44
1 to 6 months ..	3·79	·53	·21	2·60	8·09	·03	11·10	28·32	39·11	33·04
7 to 12 months.	4·06	1·81	·48	4·11	16·78	...	2·13	9·08	44·30	36·50
Total ..	2·84	·85	·24	2·57	9·33	2·27	26·75	16·27	29·82	..

Out of 21,518 children registered during the year 1912, 2,937 died before reaching the age of 30 days. The cause of death given of 2,152 of them was debility.

3,188 of the children born during the year died before reaching the age of 6 months, the cause of death being 8.09 per cent. Diarrhœa, 11·10 debility, 28·32 Diseases of the Nervous System (convulsions), and 39·11 Respiratory Diseases.

3,521 of the children born during the year died before reaching the age of 12 months, the cause of death being 5.87 per cent. infectious diseases, 16·78 Diarrhœa, 9·08 Diseases of the Nervous System (convulsions) and 44·30 Respiratory Diseases.

The death of the majority of children born, in the first month after birth, is due to debility, *i.e.*, want of vitality, premature birth, wilful or ignorant neglect, and the method adopted by the women attending the labour.

In the 2nd group—1-6 months—the causes are : Respiratory Diseases which give the highest mortality, Diseases of the Nervous System, debility, Diarrhœa, or, in other words, exposure and defective feeding.

In the 3rd group—7-12 months—Respiratory Diseases and Diarrhœa are the chief causes or, in other words, exposure and defective feeding.

Attached above is a table giving the mortality amongst infants under one year of age during 1911, comparing the figures with those of the City of Glasgow which is the largest city in the United Kingdom, except London, with a population of 784,496, approaching nearest to Bombay in point of population.

From this it will be seen that while the infant mortality is less in Glasgow, the ratios per cent. are not so widely different. For instance, the number of children dying within 30 days of their birth in Glasgow is 32 per cent. of those dying within 12 months of their births, while in Bombay it is 34·66 per cent.

The number dying between 1 and 6 months was 29·87 per cent. in Bombay, it was 35·69 in Glasgow. The number of infants dying between the ages of 7 and 12 months in Bombay was 35·45 per cent., while in Glasgow it was 32·30 per cent. of the total mortality under one year of age.

The practical remedies are :—(1) the provision of lying-in hospitals for the poor and free medical attendance, and provision of a nurse before and after child birth : the provision of lying-in hospitals will, by giving the mother good food, nursing and skilled attendance, do much towards giving the infant a start in life and enable the mother to provide breast-milk to support the child ; (2) the education of the native midwives at the hospital and the registration and licensing of these women : the control over the native women who attend the confinements is of the greatest importance, and a hospital such as suggested would do a great deal in the direction of training such women; and it would provide out-door qualified women free, or at a small fee, who would be able to attend and advise the mother during and after confinement ; (3) the introduction of a section of the Act so as to prevent a woman without a certificate and license to attend on a confinement : only women thus trained should be allowed to attend confinements and all such women licensed and registered; (4) the provision of Municipal milk depôts where women could obtain pure milk at a small cost.

The above are some practical suggestions for the reduction of infant mortality, the reduction of mortality in women during puerperal state and the improvement of the health and physique of the child.

They are all in force in most cities of Europe and America, where the state acknowledges its duty towards the people. A great deal is done by philanthropy and much by state-aided institutions; but much is done, with the result that infant mortality has been greatly reduced.

In the whole of England and Wales the infant mortality rate in 1911 was 130 per 1,000 births. It was 228.8 per 1,000 in Bombay, while in some other large towns it was as shown below:—

London	91	per 1,000.
Birmingham	111	,,
Liverpool	125	,,
Manchester	122	,,
Sheffield	107	,,
Leeds	102	,,

In 1908 a Conference was held in London at which all the principal public health authorities were represented. The Conference was presided over by the Right Hon'ble John Burns, M.P., and the following resolutions were passed:—

1. That the Education Department be urged to add instruction in elementary hygiene with reference to the dietary and rearing of infants to their present scheme for systematically training girls in the senior classes in the practice and the principles of personal hygiene and the elements of dietary.
2. That in the opinion of this Conference immediate legislation is required enabling sanitary authorities to establish or support depôts for the supply of pure or modified or sterilised milk, and to defray the cost out of the moneys available for public health purposes.

3. That in view of the information submitted, the Conference is of opinion that all still-births should be notified within 48 hours to the Medical Officer of Health of the District in which they occur, and that no burial should take place without a medical certificate.

4. That notification of all births be given within forty-eight hours to the Medical Officer of Health of the District in which they occur.

5. That in the opinion of this Conference the question of the insurance of infant lives under twelve months is one demanding serious consideration, and with a view to receiving reliable information, the Government should be asked to grant a Departmental Committee of Inquiry on the whole question.

6. (*a*) That the period of one month's abstention from factory work away from home now imposed on mothers be extended to at least 3 months, and that on their return to work evidence must be produced satisfactory to the Local Authority that proper provision has been made for the care of the child.

   (*b*) That no employer of labour shall permit a woman advanced in pregnancy to engage in factory labour, unless her ability therefor has been certified to the satisfaction of the Local Authority.

7. (*a*) That having regard to the ascertained fact that in centres of industries, where women are largely employed away from their homes, an excessive number of deaths of infants takes place, and that this is contributed to by the improper conditions existing at the houses in which infants are placed out to nurse, it is necessary that the persons by whom and the places into which infants are received should be under supervision by the Local Authority.

(*b*) That the Infant Life Protection Act be amended to remedy abuses which are not at present provided against.

8. That all preparations offered or sold as food for infants should be certified by a Government Analyst as non-injurious, and that each packet should contain its analysis.

9. That the Dairies, Cowsheds and Milkshops Order is defective and that any amendment should extend the definition of disease as applied to animals and should make the provision of regulations by local authorities compulsory. That the scope of the regulations should be extended to cover dirty milk, and should enable local authorities to prohibit the sale of any milk which fails to comply with the conditions of purity agreed upon.

10. That in the opinion of this Conference the appointment of qualified women specially trained in the hygiene of infancy is necessary as an adjunct to public health work.

11. That in the opinion of this Conference the Midwives Act, 1902, should be extended to Scotland and Ireland.

The Midwives Act, 1902.

The object of this Act is to provide skilled attention for poor women in child-birth; to reduce to a minimum the accidents in labour which result often in permanent injury to either mother or child, or both; and to abolish a class of infective conditions known as Puerperal Fever, which with skilled care are entirely preventable.

Section I of the Act prohibits any woman, who is not certified under this Act, from using the title of midwife implying that she is so certified. Provision for the certification of existing midwives is made by section II, the chief one being that any one who can show that she has been in *bona fide* practice as a midwife for twelve months before the passing of the

Act may be certified, provided she makes an application before the 1st April, 1905. Should she omit to make such application she is not allowed to practice Midwifery except under the directions of a qualified medical practitioner after the year 1910. By section X of the Act, every certified midwife is required to notify the local supervising authority, in the month of January each year, if it be her intention to practise within the area of such local authority.

The Central Midwives Board have made rules for the purpose of regulating and restricting within certain limits the practice of midwives. It is the duty of the local supervising authority to ensure that such rules are complied with and in detail the work to be done by the local authority is as follows :—

1. To exercise general supervision over all midwives practising within their area, in accordance with the rules made under the Act.

2. To investigate charges of negligence or misconduct on the part of any midwife, and to report the same to the Central Midwives' Board.

3. To suspend any midwife from practising, in accordance with the rules under the Act, if such suspension appears necessary in order to prevent the spread of infection.

4. To report to the said Board the name of any midwife, convicted of an offence, practising in the area of the local sanitary authority.

5. To supply the Secretary of the Board each year with the names and addresses of all midwives who have notified their intention to practise.

6. To report at once to the Board the death, or the change of address, of any midwife.

7. To give due notice of the effect of the Act to persons at present using the title of midwife.

The following table is of interest in comparing the rates obtaining in different parts of the world :—

Countries.	Years.							
	1881-1885.	1886-1890.	1891-1895.	1896-1900.	1901-1905.	1906.	1907.	1908.
England and Wales ..	139	145	151	156	138	132	118	120
European Russia	271	264	276	261	..	..	..	..
Hungary	..	..	250	219	212	205	208	199
Prussia	207	208	205	201	190	177	168	173
Ceylon	..	158	169	168	171	198	186	183
Italy	..	..	185	168	168	160	155	..
Japan	..	..	147	153	154	153	151	..
Belgium	156	163	164	158	148	153	132	..
France	167	166	171	159	139	143	..	..
Scotland	117	121	126	129	120	115	110	..
Norway	99	96	98	96	81	69	67	..
Sweden	116	105	103	101	91	81	77	..

Causes operating in producing a high infantile mortality.

Many of the factors are common in every locality. For convenience they may be divided into *ante* and *post-natal* causes but it must be remembered that certain causes operate during both periods of existence, *e.g.*, the employment of women both before and after labour, poverty, intemperance, and insanitary surroundings, etc.

Ante-natal causes.—Dr. J. W. Ballantine has brought into prominence the part played by ante-natal causes, including parental alcoholism, in swelling the infantile mortality rate and also lessening the birth-rate. As pointed out by him, from the third month onward the infant is brought into close relation with its mother. The placenta, amongst other functions, acts as a filter and elements which make up the fœtal tissues such as bone, muscle and blood are transmitted by the placenta from the mother's blood to the fœtus. But it does not follow that the elements pass in the same chemical combinations as those in which they are afterwards found in the fœtus. In the case of maternal Tuberculosis and certain mineral poisons, the placenta also acts as a filter. When, however, the filtering functions break down, then germs, toxins, toxic substances, and sometimes anti-toxins, agglutinins and hœmolysins flow across into the fœtus. When this happens various effects may be produced. The fœtus may die at once from the action of the poison, or it may develop a disease in a form different from that which is found in the mother, or the pregnancy may end in abortion, or, in the later stages of gestation, in premature birth, and the infant may develop the disease after birth and either die or recover from it. There is another evil effect that the failure of the filter may have on the infant, *viz.*, the production of malformations, deformities and monstrosities. According to the same writer, there are three ways at least in which ante-natal morbid conditions may influence infantile life and health :—(1) *the production of abortions* which may result from conditions such as Syphilis, Nephritis, Alcoholism, etc. The life lost, it is true, is that of an immature organism but one which, if ante-natal conditions had continued to be normal, would in a few months have been of precisely the same value as that of any full-time infant. In city populations it is stated that one pregnancy in 5 ends in abortion : if this be true, it is at once evident that the prevention of all abortions would increase the birth-rate by 20 per cent. From a statistical point of view it may be true that abortions are not infantile deaths and therefore do not swell the mortality figures but at the same time it is the loss of a potential infant. (2) *influence of premature births.*—Premature labour tends to increase the infantile death-rate. The infant has a better chance of surviving if it comes from a healthy mother and has been delivered at an earlier date, not because of disease, but in order to get it safely through contracted maternal canals. Premature infants born to diseased mothers are very difficult to save alive, *e.g.*, when the mother has Syphilis, or eclamptic seizures, or chronic Bright's Disease or is an habitual inebriate, or has had placenta praevia or accidental hæmorrhage. The child may die owing to the transference to it from the mother of the germs of her disease, or again the child may die by reason of its prematurity alone. (3) *influence of fœtal diseases and deformities.* Ante-natal morbid states of the infant tend to increase the infantile death-rate even when they do not cause either abortion or premature labour. The disease or deformity may produce various results, *e.g.*, the health of the fœtus may have been so disturbed as to result in ante-natal death and the birth into the world of a dead fœtus, or it may make it impossible for the fœtus to stand the strain of being born, causing it, in other words, to be still-born. Again the post-natal life of the infant may be very precarious as the result of deformities or disease, *e.g.*, hare-lip and cleft palate, when combined, render feeding a difficult problem; similarly congenital heart disease greatly increases the risk in the event of the development of Bronchitis or Pneumonia. Fœtal Ichthyosis may, after birth, cause pathological alterations in the infant's internal organs which sooner or later result in death; and, lastly, any grave state of a mother in her pregnancy, as for instance, renal disease or Hyperemesis, may so interfere with the ante-natal nourishment of the infant in the uterus as to cause it to suffer from what is vaguely termed congenital debility.

Influence of parental alcoholism.—Over-indulgence in alcohol increases sterility, abortions, premature labour, dead births, and the birth of delicate children especially seen in chronic cases. Its influence is due rather to changes in the maternal kidneys and placenta than to any direct influence which the drug has upon the fœtal tissues themselves. There is a sensibly higher death-rate among the infants of the mother whose inebriety was developed at an early period. In not a few of the cases in which a mother gave birth to a deformed child there was evidence of chronic alcoholism.

Appended is a table showing the deaths of children under one year from immaturity per 1,000 births during the period 1886-1908.

Cause.	Proportion of Deaths to 1,000 Births (both sexes).						
	1886 to 1890.	1890 to 1895.	1896 to 1900.	1901–1905.	1906	1907	1908
Premature Births ..	16·1	18·4	19·6	20·2	20·4	19·8	19·9
Congenital Defects ..	4·2	4·7	4·9	5·9	6·6	6·6	6·7
Debility, Atrophy and Inanition.	21·7	21·5	20·5	17·9	16·1	15·0	15·0
TOTAL ..	42·0	44·6	45·0	44·0	43·1	41·4	41·6

As stated by Newman it is evident, if infants die within a few days or hours of birth, or, even if dying later, show unmistakeable signs of having been unequal to the call of bare physical existence, that there must be something more than external conditions of food and management which is working to their hurt. The explanation is clearly to be found in ante-natal causes.

Ratio of mortality among Infants to 1,000 Births registered in Bombay City.

Cause.	1886-1890.	1891-1895.	1896-1900.	1901-1905.	1906	1907	1908
Premature Birth ..	1·1	2·0	4·3	5·3	9·6	9·5	8·8
Debility	115·8	108·3	198·8	178·1	175·8	145·8	142·4
All Causes	397·9	464·6	711·3	530·0	534·7	423·6	450·1

Influence of the employment of married women in factory labour.

The result of Reid's enquiry into the mortality of children under one year in three classes of towns in Staffordshire are well summarised in the following table—

Classification according to percentage of married and widowed workers to female population between the ages of 18-50 years.	12 % and over.	Under 12 % but over 6 %	Under 6 %
Census population, 1901 ..	132,299	263,868	131,508
Infantile Mortality, 1881-1890.	195	165	156
,, ,, 1891-1900	212	175	168
,, ,, 1901-1904	193	156	149

The delegates at the National Conference held in London in 1908 were of opinion, from the facts collected by various authorities, that the period of one month's abstention from work away from home now imposed upon mothers should be extended to at least three months, and that on their return to work evidence must be produced satisfactory to the local authorities that proper provision has been made for the care of the child, and that no employer of labour should permit a woman advanced in pregnancy to engage in factory labour unless her ability therefor has been certified to the satisfaction of the local authority. Reid, who has written much on this subject, found that taking a large number of towns in England, irrespective of geographical position, and classifying them according to the proportion of married women workers in each, the infantile mortality rates varied in direct proportion to the number of such workers. Apart from the more direct results of mothers neglecting their home duties after their infants are born, there is the effect, which cannot very readily be demonstrated by figures, as regards the viability of children as yet unborn of mothers engaging in other than domestic work up to the time of their confinements.

Influence of Illegitimacy on Infantile Mortality.

The death-rate among illegitimate children is very much greater than is the case with legitimate, as will be seen from the following table extracted from the Registrar-General's Report for 1908.

INFANTILE MORTALITY IN ENGLAND AND WALES, 1908—ALL CAUSES.

Age	England & Wales.		Urban Counties.		Rural Counties.	
	Legitimate.	Illegitimate.	Legitimate.	Illegitimate.	Legitimate.	Illegitimate.
Under 3 months	61·78	128·25	64·96	136·88	56·75	109·74
3–6 months..	22·49	50·83	25·31	56·91	16·51	34·08
6–12 months	31·48	54·01	35·98	61·90	23·24	31·70
Under 1 year	115·75	233·09	126·25	255·69	96·50	175·52

In a subsequent note we find that the excess of illegitimate mortality is greatest from Diarrhœa and wasting diseases and least from the group of common infectious diseases: the first-named cause being that upon which neglect would probably have the most influence, and the last that upon which it would have the least.

A frequent cause of infantile mortality is the ignorance of the mother in regard to the proper method of feeding and clothing a child. Apart from ignorance, there is the question of insanitary houses and surroundings and the difficulties of obtaining a pure milk supply and retaining it in such a condition until consumed. Probably largely due to these difficulties and to the inability of the mother to estimate, at their proper value, the plausible advertisements of some of the patent food vendors, many such foods are now given to infants. To meet these conditions it has been proposed, and in many places actually given effect to, to give a course of instruction in the elementary schools to girls in elementary hygiene, with special reference to the value of perfect cleanliness both of the person and of the surroundings, and in the dietary and clothing of infants ; also to establish pure milk depôts so as to bring a supply of pure modified or sterilised milk within the reach of mothers who, for one reason or another, are unable to suckle their infants. In regard to patent foods, it is suggested that legislation should be set in motion to compel all preparations offered for sale or sold as foods for infants to be certified by a Government Analyst as non-injurious and that each packet should contain a clear statement of the analysis of its contents.

Influence of Life Insurance on Infantile Mortality.

Much has been said and written in reference to infantile insurance and there have been several Parliamentary inquiries into the subject. One of the earliest was that of the Select Committee of the House of Commons in the Friendly Societies Bill of 1854 when the Committee reported as follows. :—

> " Your committee draws this conclusion that the " instances of child-murder, where the motive of the " criminal has been to obtain money from a Burial " Society, are so few as to by no means impose upon " Parliament any obligation, for the sake of public " morality, to legislate specially with the view to the " prevention of that crime. No sufficient grounds " exist for the general suspicion which seems to have " been entertained on the subject and this suspicion " appears to have been entirely founded upon the few " cases brought to trial, exaggerated by the horror " with which the idea of a crime so heinous would " naturally be regarded."

Writing in 1894, the Chief Registrar of Friendly Societies of England and Wales says : " upon considering the evidence adduced before all these Committees and the Friendly

Societies Commissioners, I do not think it has materially altered the conclusion at which the Committee of 1854 arrived at."

By Clauses 62—67 of the Friendly Societies Act of 1896, all Industrial Assurance Companies and Friendly Societies are bound by certain regulations whereby the amount payable on the death of a child under 5 years of age is limited to £6 and, if under ten years, to £10.

That the insurance of infantile life is open to abuse is evidenced by the great caution exercised by some of the leading companies, and the definite rules laid down among which may be found the following: (1) No child is to be proposed for insurance until 14 days old. If death occurs within three months of the policy being effected, no amount is payable, so that no money can be received until a child is 4 months old. (2) Illegitimate children are not to be accepted till three years old. (3) A Superintendent's report is necessary in the case of twins under one year of age.

So notorious has the unsatisfactory business in certain portions of some towns been, that some companies refuse to entertain proposals from residents in those quarters unless the Superintendent has seen the proposer and specially reported upon the situation.

As these are merely departmental rules of certain companies, it is obvious that, in face of the great competition that exists, companies not in the first flight may by slack administration place grave temptations in the way of weak individuals. At the National Conference on Infantile Mortality, London, 1906, it was resolved that in the opinion of the Conference the question of the insurance of infant lives under 12 months is one requiring serious consideration and, with a view to securing reliable information, the Government should be asked to appoint a Departmental Committee of Inquiry upon the whole subject.

Infantile Mortality considered from the point of view of the diseases which actually cause death.

The following table is of great interest as showing the cause of death and the period of life at which death occurs from those various causes :—

Cause of Death.	Under 1 Day	1 Day and under 1 Week.	PROPORTION OF DEATHS TO 1,000 BIRTHS.															Under 1 year.
			WEEKS			MONTHS												
			1	2	3	Under 1 Month	1	2	3	4	5	6	7	8	9	10	11	
1. Common Infectious Diseases.	..	0·0	0·01	0·05	0·10	0·16	0·52	0·46	0·47	0·47	0·49	0·60	0·67	0·77	0·86	0·89	1·05	7·41
2. Diarrhœal Diseases ..	0.00	0·05	0·17	0·39	0·39	1·00	2·09	2·46	2·56	2·39	2·02	1·76	1·45	1·26	1·14	0·94	0·83	19·90
3. Wasting Diseases ..	10·07	10·33	3·88	3·30	2·10	29·68	4·64	2·64	1·64	1·05	0·74	0·55	0·40	0·35	0·25	0·23	0·20	42·37
4. Tubercular Diseases ..	0·00	0·01	0·01	0·03	0·03	0·08	0·23	0·38	0·46	0·51	0·49	0·44	0·44	0·47	0·41	0·37	0·37	4·65
5. Miscellaneous Diseases.	1·42	2·42	1·81	1·99	1·71	9·35	6·10	4·64	3·89	3·38	3·06	2·89	2·95	2·74	2·51	2·36	2·23	46·10
1. Small-pox	..	..	..	..	..	..	..	..	..	0·00	..	..	..	..	..	..	..	0·00
Chicken-pox	..	..	..	..	..	..	..	..	..	0·01	..	0·01	0·01	0·01	0·01	..	..	0·05
Measles	..	..	..	0·01	0·01	0·02	0·03	0·02	0·01	0·03	0·07	0·14	0·19	0·24	0·31	0·37	0·46	1·89
Scarlet Fever	..	..	..	..	..	..	..	..	0·01	0·01	..	0·01	0·01	0·01	0·03	0·02	0·02	0·12
Diphtheria and Croup ..	..	..	..	..	..	..	0·01	0·01	0·01	0·01	0·02	0·02	0·02	0·04	0·05	0·05	0·07	0·31
Whooping-Cough ..	..	..	0·01	0·04	0·09	0·14	0·48	0·43	0·44	0·41	0·40	0·42	0·44	0·47	0·46	0·45	0·50	5·04
2. Enteritis	..	0·03	0·06	0·08	0·07	0·24	0·37	0·45	0·38	0·36	0·27	0·24	0·20	0·15	0·14	0·12	0·11	3·03
Gastro-Enteritis ..	..	0·01	0·04	0·08	0·07	0·20	0·31	0·31	0·34	0·31	0·26	0·20	0·19	0·13	0·14	0·11	0·09	2·59
Gastro-Intestinal Catarrh	..	0·00	0·01	0·02	0·03	0·06	0·10	0·11	0·10	0·11	0·08	0·06	0·02	0·02	0·03	0·03	0·03	0·75
Diarrhœa (other forms) ..	..	0·01	0·06	0·21	0·22	0·50	1·31	1·59	1·74	1·61	1·41	1·26	1·04	0·96	0·83	0·68	0·60	13·53

Cause of Death.	Under 1 Day.	1 Day and under 1 Week.	PROPORTION OF DEATHS TO 1,000 BIRTHS.															Under 1 Year.
			WEEKS.			MONTHS.												
			1	2	3	Under 1 Month	1	2	3	4	5	6	7	8	9	10	11	
3. Premature Birth ..	7·41	6·25	1·88	1·54	0·91	7·99	1·27	0·34	0·14	0·06	0·02	0·02	0·00	0·01	..	..	..	19·85
Congenital Defects ..	1·19	2·02	0·90	0·55	0·30	4·96	0·66	0·35	0·19	0·13	0·10	0·08	0·07	0·06	0·04	0·04	0·04	6·72
Want of breast milk, Starvation.	..	0·02	0·03	0·04	0·06	0·15	0·17	0·16	0·09	0·08	0·06	0·04	0·03	0·02	0·02	0·01	..	0·83
Atrophy, Debility, Marasmus.	1·47	2·04	1·07	1·17	0·83	6·58	2·54	1·79	1·22	0·78	0·56	0·41	0·30	0·26	0·19	0·18	0·16	14·97
4. Tuberculous Meningitis..	..	0·01	..	0·01	0·01	0·03	0·03	0·07	0·10	0·13	0·16	0·16	0·17	0·19	0·15	0·14	0·14	1·47
Tuberculous Peritonitis & Tabes Mesenterica.	..	..	0·01	0·01	0·01	0·03	0·12	0·20	0·23	0·23	0·20	0·15	0·15	0·16	0·14	0·11	0·11	1·83
Other Tubercular Diseases	..	..	..	0·01	0·01	0·02	0·08	0·11	0·13	0·15	0·13	0·13	0·12	0·12	0·12	0·12	0·12	1·35
5. Syphilis	0·02	0·03	0·08	0·10	0·07	0·30	0·32	0·21	0·14	0·09	0·05	0·04	0·03	0·02	0·02	0·02	0·01	1·25
Rickets	..	..	..	..	..	..	0·01	0·03	0·03	0·03	0·04	0·05	0·05	0·06	0·05	0·05	0·06	0·46
Injury at Birth	0·60	0·31	0·05	0·02	0·01	0·99	0·01	..	..	..	..	..	..	..	..	..	..	1·00
Convulsions	0·33	1·58	0·90	0·73	0·57	4·11	1·69	1·23	0·96	0·72	0·51	0·40	0·32	0·26	0·23	0·17	0·15	10·75
Suffocation	0·10	0·20	0·06	0·07	0·11	0·54	0·37	0·30	0·18	0·14	0·06	0·03	0·03	0·01	0·01	0·01	0·01	1·69
Pneumonia	..	0·04	0·11	0·17	0·20	0·52	1·01	0·91	0·88	0·82	0·90	0·95	1·06	1·10	0·99	0·99	0·95	11·08
All Causes	11·49	12·81	5·88	5·76	4·33	40·27	13·58	10·58	9·02	7·80	6·80	6·24	5·91	5·59	5·17	4·79	4·68	120·43

Zymotic Death-Rates.

The term 'zymotic' is applied to the seven principal infectious diseases, *viz.*, Small-pox, Measles, Scarlet Fever, Diphtheria, Pertussis, Diarrhœa and Fever (which term includes Typhoid, Typhus and simple continued Fever.)

There are various methods of calculating the rate, *e.g.*, (1) As a proportion of deaths to persons attacked; this method is useful in determining the virulence of an outbreak and also in deducing the effects of treatment, but it is open to objection for purposes of comparison as the two groups compared may have a different age and sex distribution and zymotic diseases are known to vary in fatality according to age and sex. (2) The rate may be stated as a proportion to the deaths from all causes. (3) The deaths from each particular zymotic may be stated as a proportion per 1,000 of the population; or, (4) the deaths from each particular disease at a given age period may be stated as a proportion per 1,000 of the population living at that particular age period. The third method is that adopted by the Registrar-General and thus, like the birth and death-rates, the zymotic rate is calculated on the estimated population of the district, *e. g.*, Population 20,000, deaths 40, then the rate

$$\frac{40 \times 1{,}000}{20{,}000} = 2{\cdot}0.$$

Mortality per 1,000 living from certain Epidemic Diseases:—

	1881–1885.	1886-1890.	1891-1895.	1895-1900.	1901-1905.	1906.	1907.	1908.
Measles.								
England and Wales..	0·41	0·47	0·41	0·42	0·33	0·27	0·36	0·23
Austria	0·48	0·56	0·42	0·38	0·34	0·33	..	..
Prussia	0·42	0·42	0·27	0·26	0·25	0·24	0·18	0·19
Scarlet.								
England and Wales..	0·44	0·24	0·18	0·13	0·13	0·10	0·09	0·08
Italy	..	0·31	0·20	0·11	0·05	0·08	0·09	0·10
Austria	0·62	0·56	0·54	0·56	0·45	0·38	..	..
Diphtheria.								
England and Wales..	0·16	0·17	0·25	0·27	0·20	0·18	0·16	0·16
Japan	0·03	0·04	0·07	0·13	0·09	0·09	0·09	..
Prussia	1·72	1·57	1·34	0·59	0·40	0·27	0·24	0·25
Enteric.								
England and Wales..	0·22	0·18	0·17	0·17	0·11	0·09	0·07	0·07
New Zealand ..	0·23	0·22	0·17	0·14	0·08	0·05	0·06	0·10
Switzerland	0·29	0·16	0·11	0·08	0·06	0·05	0·05	..
Pertussis.								
England and Wales..	0·46	0·44	0·40	0·36	0·30	0·24	0·29	0·28
Japan	..	..	..	..	0·05	0·07	0·07	..
Prussia	0·52	0·51	0·45	0·42	0·36	0·31	0·23	0·28
Bombay City.								
Measles	·6	·5	·07	1·0	·6	·9	·1	·6
Scarlet	..	..	..	..	..	..	..	..
Diphtheria	·003	..	·002	·004	·003	·003	..	·003
Enteric	·02	·02	·02	·05	·17	·1	·1	·1
Pertussis	·08	·09	·1	·2	·06	·02	·01	·01

In the decade 1881—1890 the zymotic rate in England and Wales was 2·34 per 1,000. Of later years it has shown a tendency to fall; in 1894 it was 1.76 per 1,000. At no time can the rate be taken as quite accurate, as deaths due to protracted sequelæ of acute infectious diseases are sometimes credited to the secondary cause and not to the true primary one, *e. g.*, Bronchitis and Pneumonia may be given as the primary cause of death and the fact that they may have followed on Measles or Pertussis is not stated.

It will be seen that as far as England and Wales are concerned, there has been a fall in mortality from Measles, Scarlet Fever, Enteric and Pertussis since the period 1881-1885. The death-rate from Diphtheria has however remained more or less unaltered.

The statistics for Bombay City are given in the following table. Rates per 1,000:—

Year.	1895.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Diarrhœa ...	1·44	3·09	3·33	2·40	2·05	1·62	2·90	2·12	3·04
Small-pox ...	0·32	2·78	0·28	0·08	1·04	0·48	1.03	·45	·99
Measles ...	0·66	0·79	0·95	0·01	0·66	0.07	·18	·66	·21
Pertussis ...	0·33	0·03	0·02	0·01	0·01	0·007	·01	...	·02
Enteric ...	0·04	0·07	0·13	0.11	0·11	0·09	·15	·14	·15

Age and sex both appear to exert an influence on the mortality from zymotic diseases. Diarrhœa, Erysipelas and Small-pox have a maximum mortality in the first year of life, Measles in the second, Scarlet Fever in the third and Diphtheria in the fourth. As regards sex, the mortality is greatest in females in Erysipelas, Diphtheria and Pertussis.

Crude annual death-rates, England and Wales, from the principal Epidemic Diseases. Mortality per million living :—

Year.	Measles.	Small-pox.	Scarlet Fever.	Diphtheria.	Pertussis.	Typhus.	Typhoid.	Diarrhoea.
1881 ..	280	119	548	121	415	21	212	570
1891 ..	436	2	170	173	468	5	168	480
1892 ..	459	15	190	222	454	3	137	520
1893 ..	373	49	235	318	342	5	229	1,000
1894 ..	391	27	167	291	410	4	159	359
1895 ..	377	7	149	259	315	2	175	901
1896 ..	570	17	177	241	429	2	166	564
1897 ..	408	..	147	246	367	2	156	869
1898 ..	419	8	113	243	223	1	181	957
1899 ..	314	5	117	292	318	1	198	973
1900 ..	394	3	119	290	356	1	193	730
1901 ..	276	10	133	273	313	1	155	926
1902 ..	392	75	148	236	297	2	126	429
1903 ..	274	23	125	182	285	2	100	554
1904 ..	363	15	111	170	352	1	93	879
1905 ..	324	4	112	160	255	1	89	601
1906 ..	273	1	101	177	241	..	92	886
1907 ..	361	..	92	164	293	1	67	305

DEATH-RATES IN RELATION TO OCCUPATION.

Various methods of classification may be adopted, a very useful one being professional, domestic, commercial, agricultural and unoccupied. Similarly, there are various methods of comparison *e.g.*, different trades may be compared on the basis of the mean age at death of those engaged ; or again, the comparison may be made by the proportion between the numbers engaged in and dying in any occupation expressed as a rate per 1,000. Both these methods fail to take into account the different ages of those engaged in the various trades, and for that reason the best method is that which compares the mortality of those engaged in one occupation of a definite age with the mortality of those engaged in another of the same age.

Now, in all statistics relating to occupational mortality, there are certain sources of error arising chiefly from vague-ness, in the census returns, of occupations, or from the fact that those who follow different industries do not always start on equal terms, *e.g.*, in general, a weakling would not become a navvy or a blacksmith, but rather take to a trade requiring less strength. On the other hand, a weakly individual may start in an occupation which requires much strength and endurance and finally have to abandon it for a trade less strenuous and so tend to raise the death-rate in the latter.

The causes which render certain trades more or less harmful include bad lighting and ventilation of work-rooms with perhaps over-crowding, long hours and overwork, exposure to extremes of temperature and to vapours and gases and to dust, whether mineral or organic; moreover, certain trades appear to encourage the habit of intemperance. Dr. Tatham in his letter to the Registrar-General on the mortality in certain occupations in the three years 1900—1902 deals at length with the mortality incident to the chief industries of England. This letter appears as a supplement to the 65th report of the Registrar-General, 1908. Dr. Tatham has selected as the main working part of life the age period 25—65 and has prepared a comparative mortality figure for each occupation depending on the rates of mortality at the several age-groups.

The disproportionate effects of work and no occupation are well shown in the following table, which represents the death-rate per 1,000 living of occupied and unoccupied males between 25 and 65 :—

Class of Persons.	25—45 Years.	45—65 Years.
Occupied males	7.84	22.73
Unoccupied males	36.31	57.01

This table shows that between 25 and 45, unoccupied males die four times as fast as occupied and at the later period of life 45—65 nearly 2½ times as fast. During the last ten years the mortality of the occupied has declined by 16, which decline has been shared by more or less all industries; but among the following there has been an increase:—lacemakers, hosiers, copper and tin miners, general shopkeepers and labourers. During the same period the mortality of the unoccupied has increased by ⅛th.

The effects of various occupations on health are shown in various tables, from which one sees that at the head of the list in regard to healthiness of work are the members of the various religious denominations, followed by gardeners, nurserymen and agriculturists in general. At the opposite end of the list are to be found general labourers, tin miners, and innkeepers with their servants. Medical men have a comparative figure of 950 to 750 of the legal profession and 524 of the clergy.

COMPARATIVE MORTALITY FIGURES, OCCUPIED AND RETIRED MALES, AGE 25—65 :—

Clerical	524
Agriculturists	602
Schoolmasters	665
Grocers	729
Coal merchants	731
Ironmongers	741
Legal	750
Tanners	774
Artists, etc.	823
Milk-sellers	832
Drapers	845
Millers	890
Bakers	922
Domestic servants	927
Stationers	931
Bookbinders	934
Saddlers	945
Medicals	952
Tobacconists	962
Lithographers	964
Fishermen	967
Shoemakers	984
Commercial travellers	988
Printers	994
Chemists	999
All Occupied and Retired Males	1,004
Tailors	1,027
Metal workers, including—	1,027
(*a*) Lead workers	1,408
(*b*) Zinc workers	889
(*c*) Copper workers	1,090
(*d*) Brass workers	1,154
(*e*) Tool, file and saw-makers.	1,315
Hatters	1,137
Butchers	1,148
Transport service	1,190
Hair dressers	1,196
Musicians	1,261
Publicans	1,808

As to the causes of death, Pulmonary Tuberculosis and Diseases of the Respiratory System taken together account on the average for more than one-third part of the total mortality of men in the main working time of life, and in some industries the proportion is much higher than this. File makers, potters, cutlers, copper and tin miners have from 4—10 times the mortality from Phthisis and Respiratory Diseases that obtains amongst agriculturists. Coal, iron and stone miners and carpenters appear to suffer less severely than the above from Pulmonary Diseases. Agriculturists appear to have the same death-rate from Respiratory Diseases in general as from Tubercular Phthisis, but the following table gives a list of occupations in which the workers suffer more from Tubercular Phthisis :—

Workers in Industries.	Phthisis.	Diseases of the Respiratory System.
Agriculturists..	85	86
Carpenters	150	126
Bakers	165	162
Carpet manufacturers ..	180	179
Bricklayer masons	194	183
Rope-cord makers	207	174
Cycle, motor manufacturers..	217	164
Tinplate manufacturers ..	221	189
India-rubber workers ..	244	183
Brass workers..	272	228
Wood turners..	271	233
Farriers	316	217
Glass manufacturers.. ..	283	268
Chimney sweeps	284	272
Lead miners	324	274
File-makers	387	325
Cutlers, scissors makers ..	533	315
Tin miners	816	741

On the other hand, in the following occupations the workers suffer less from Tubercular Phthisis than from Respiratory Diseases in general, *viz.*, iron-stone miners, coal miners, wool manufacturers, millers, blacksmiths, gaswork men, stone quarriers, chemical and cotton manufacturers, zinc workers, lead workers, coal heavers, gunsmiths, copper workers, potters and copper miners.

The effects of breathing foul, though not necessarily dusty, air are seen in the following table which gives a list of nineteen industries in which the workers appear to suffer injury in various degrees. The table indicates that in 14 industries the workers succumb to Pulmonary disease from twice to three times as fast as do agriculturists generally. It further shows that in 18 out of the 19 industries the workers die more from Phthisis than from diseases of the lungs other than Phthisis, the excess ranging from 13% in the case of hatters to 139% in the case of lithographers.

Workers in Industries.	Phthisis.	Diseases of the Respiratory System.
Agriculturists	85	86
Artists and engravers ..	156	111
Drapers	203	105
Watchmakers..	189	127
Commercial clerks	202	121
Saddlers	224	122
Lithographers	261	109
Law Clerks	251	125
Lock and key-makers ..	224	161
Cabinet-makers	228	166
Tailors	248	157
Textile dyers	193	218
General shopkeepers ..	354	308
Shoemakers	271	149
Tobacconists	246	177
Hair dressers	258	172
Printers	300	131
Bookbinders	275	174
Musicians	324	178
Hatters	280	248

Effect of Chronic Lead-poisoning.

The following table, which refers to the occupied males only, shows the mortality due to lead poisoning in certain trades. Taking the standard mortality as unity, lead workers have a mortality 103 times as great, filemakers 57 times, painters and plumbers 22 times, potters 9 and glass workers 8. With the exception of painters and plumbers the figures show a considerable decline on those of the previous decade. This decline is possibly due to the supervision which is exercised on those trades, carried out on a large scale, by factory inspectors, etc., as opposed to the smaller trades such as plumbing and painting, where the same trained supervision is not in force.

Workers in Industries.	Comparative Mortality figures.	
	1900—01—02.	1890—91—92
Lead workers	103	243
File makers	57	87
Plumbers and painters ..	22	22
Potters	9	19
Glass workers	8	13
All occupied males ..	1	1

The Phthisis Death-Rate.

A high Phthisis death-rate in a city or a division thereof may be due to defective conditions of housing or of the workshops in which the people are employed. These defects may take the form of dampness of sites, bad construction and drainage, bad lighting and ventilation, or overcrowding. Again certain trades by the very nature of the processes carried out predispose the operative to this disease. In addition, poverty, drunkenness and ignorance largely assist in maintaining a high death-rate in a district already affected, so also do certain customs, *e.g.*, the observance of strict *purdâh* in the case of Mahomedan women must be held to be at least partly responsible for the very high death-rate from Phthisis in such. The influence of milk drawn from cows suffering from tubercular disease of the udder must not be overlooked, and there is now a considerable tendency towards the belief that many cases of adult Tuberculosis are but a recrudescence of tubercle acquired in early childhood from infected milk.

The following table gives the mortality per 1,000 living from Pulmonary Tuberculosis, in the countries specified, for the years 1881—1908 :—

Countries.	1881–85.	1886–90	1891-95	96–1900	1901-05.	1906.	1907.	1908.
England and Wales.	1·83	1·64	1·46	1·32	1·22	1·15	1·14	1·12
Ireland	2·08	2·12	2·14	2·13	2·15	2·04	2·02	1·95
Prussia	3·13	2·90	2·47	2·08	1·91	1·71	1·70	1·65
Japan	..	1·01	1·36	1·45	1·46	1·56	1·54	..
Italy	..	1·37	1·29	1·25	1·16	1·22	1·24	1·22
New Zealand ..	0·91	0·84	0·81	0·78	0·70	0·62	0·67	0·64
Ontario Province ..	1·25	1·16	1·14	1·41	1·29	1·31	..	..
Switzerland.. ..	2·09	2·13	1·99	1·90	1·89	1·84	1·72	..

In Bombay City the mortality is as under for the years 1900—1912.

BOMBAY CITY.												
1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
9·97	8·39	5·09	3·66	3·82	3·29	3·64	2·94	2·44	2·46	2·33	2·12	2·22

Influence of Density of Population on the Death-rate.

The density of population can be calculated in terms of so many persons to each square mile, or in terms of so many acres occupied by each person in the population. Tables compiled in former years would appear to show that when there are more than 400 persons per square mile, then the death-rate increases with the density, other things being equal, not in direct proportion but as the root.

Newsholme, however, has pointed out that there is little or no connection between such density *per se* and a high mortality, and that the true index of density is the number of persons per occupied room. Modern experience in regard to hotels, flats, barracks, etc., has shown that if a proper regard is paid to the sanitary construction and conduct of a building, the influence of the number of persons per acre is practically negligible. Two localities may have the same absolute density of population and yet the death-rates may vary widely, by reason of the fact that one district may be well planned with wide main streets and open cross streets and the other may consist mostly of closed courts and alleys with no through ventilation, and bad lighting. Of course, given precisely similar conditions in two districts, then naturally the more persons there are per acre, the greater should be the death-rate, if only on account of the increased facilities for the spread of infectious diseases. There must be a limit to the number of houses which can be erected on a given area without causing injury to health, and it has been distinctly shown that, in similar districts, a definite relationship exists between density per acre and the death-rate, but this is due to the fact that, all things being equal, density per acre is dependent on the number of persons per room, and that, beyond doubt, exercises a powerful influence on sickness and the death-rate for two reasons: (1) the greater the number of persons per acre the more are infectious diseases spread and the greater the injury to health from breathing impure air; and (2) a higher proportion of persons per acre room implies a greater degree of poverty, with the result that food is liable to be deficient both in quantity and quality; and also intemperance and vice in general add their effects to those produced by overcrowding. In England, as a whole, it is found that the percentage of over-crowded tenements is higher among one than two roomed tenements and much higher in the latter than among three roomed, falling to a comparatively low point for four roomed tenements. Dr. Niven has published certain statistics in this connection relating to the City of Manchester.

Rooms in tenement.	Death-Rates per 1,000.			
	All Causes.	Zymotic.	Phthisis.	Respiratory Disease in general.
1	32·7	7·4	2·4	7·6
2	21·3	4·5	1·8	4·6
3	13·7	1·9	1·2	2·4
4	11·2	1·0	0·7	2·0

That density *per se* is not the cause of a high rate is shown by the experiences of the huge hotels and flats now existing in many large cities. Newsholme shows that in 1889 the vital statistics of the 20,000 inhabitants of the Peabody Buildings, London, with a density of 750 persons per acre, compared favourably with those of London generally with an average density of 49 per acre, as regards infantile mortality and the total death-rate, though from Phthisis, Scarlet Fever, Diphtheria, Measles, and Pertussis, there was a higher death-rate.

Influence of Sex on Mortality.

On the whole the death-rate among women is much less than among men, but the mortality appears to be higher than that of men from Rheumatism, Erysipelas, Diphtheria, Cancer, Anæmia and Pertussis.

The following table gives the annual rates of mortality per 1,000 living, corrected for age and sex constitution from 1881 to 1908:—

	Males.	Females.
1881—1885	19·7	17·8
1886—1890	19·6	17·5
1891—1895	19·6	17·5
1896—1900	18·8	16·5
1901—1905	17·1	15·0
1906	16·4	14·4
1907	16·0	14·1
1908	15·7	13·7

During this period the death-rate has declined by 31·3 per cent. This decline is shared by both sexes, but in somewhat different proportions. In males the rate fell by 29·6 per cent. and in females by 33·5 per cent.

The higher mortality amongst males is mainly caused by excess of deaths from immaturity, convulsions, by the greater liability of men to deaths from violence in following their occupations, and to Tuberculosis, Pnuemonia, Respiratory Diseases and alcohol.

Influence of Season.—As a rule mild winters and cool summers lower the death-rate, the former especially in the old and the latter in the young, especially in infants, the saving arising chiefly from the drop in deaths from Diarrhœa. There is generally a summer maximum in Diarrhœa and Thrush; in winter, in diseases of the heart, lungs and liver, and in spring, in Small-pox and Pertussis.

Influence of Age:—This appears marked in certain diseases: Diarrhœa, Erysipelas, Small-pox and Pertussis have a maximum mortality in the first year (Small-pox has a second maximum at age 25). Measles, Scarlet Fever and Diphtheria have their highest death-rates during the first few years of life. Cancer increases from age 25 onward, and Phthisis, which appears to be at a minimum at the 5—10 age period, increases thereafter up to 45.

Death-rates are said to be influenced by the birth-rate. If there is a high birth-rate there must be a large proportion of infants and young children in the population, and as the death-rate in infants is high, the general death-rate of the district must be raised; but, if this high birth-rate be continued over a long period, then there will be not only a large number of infants but also of young adults in the population of an age at which mortality is usually low; and moreover, one must remember that a high birth-rate implies the presence in the district of adults at the child-bearing age, and among them also the death-rate is low. The mean age of a population really governs the death-rate, for the lower the mean age of the living, the lower should be the death-rate.

CLASSIFICATION OF STATISTICAL DATA.

The data thus obtained are classified or grouped under various headings. For example, so far as the duties of the Medical Officer of Health are concerned, the births are classified according to sex, while the deaths are classified according to sex, age and diseases.

In large urban districts the system of classification usually adopted is that of the Registrar-General, but for small urban or rural districts the limited tabular returns required by the Local Government Board will be sufficient. In either case, however, printed forms should be used for classification, and arranged to contain all the data for weeks, months or quarters.

In classifying data of any kind, it is essential that the individual units should have precise and definite characters, so that every unit in a group should be strictly included in that group. Then again, the dividing character of every group should be so distinct and clearly defined as to afford no room for doubt under which group or heading every unit should be classified. Care also should be taken that no unit should be classified so as to appear in two allied groups at the same time. Thus, we shall suppose that a death has been returned as due to Phthisis, as the primary and Diarrhœa as the secondary cause; it would obviously vitiate the results if the single case were classified under the heading of Diarrhœa, and also under that of Phthisis.

It is most important that this rule should be strictly observed. Now, in practice, certain difficulties arise when two diseases are entered on the death certificate, and in neither case is the duration of the disease mentioned. Doubt naturally arises as to which disease the death is to be attributed for statistical purposes. To meet this difficulty certain general rules have been drafted so as to secure uniformity of data.

General Rules.

(1) *Constitutional Diseases* come before any other except Zymotic, so that Phthisis comes before any Respiratory Disease in whatever order they may be in the certificate.

(2) *Circulatory Diseases* take precedence of Urinary,

e.g., Heart Disease, Nephritis,	} classify as Heart Disease.

(3) *Urinary Diseases* take precedence of Respiratory,

e.g., Bronchitis,
Nephritis, } classify as Nephritis.

(4) *Influenza.*

If any disease of longer duration be given then classify as that, *e.g.*—

Influenza 2 days, Pneumonia 8,=Pneumonia.

But Influenza 6 days, Pneumonia 2,=Influenza.

If no duration is given, then classify under the first-named.

5. It is very desirable that medical practitioners should use in their certificates of death only those terms which are recognised by the Royal College of Physicians, London. The cause of the death should be stated precisely and briefly, English names for diseases being used in preference to their equivalents in other languages.

6. Vague terms, such as decline, consumption, tabes, cachexia, etc., should be avoided, and hæmorrhage should not be assigned as a cause of death without an indication of its origin and probable cause. So also dropsy should not be given without particulars as to probable origin, *e. g.*, in some disease or other of the heart, liver or kidneys.

7. In certifying death from Small-pox, the patient's condition with respect to vaccination should be most carefully stated, *e. g.*, (1) no evidence of any vaccination; or (2) vaccinated in infancy, only stating the number and size of scars combined; or (3) vaccinated only after exposure to Small-pox (the incubation period of which is nearly always twelve days); (4) stated to have been vaccinated but no scars visible.

Always state the size of the scars when combined in terms of fractions of a square inch.

Various Examples.

Icterus, Neonatorum, classify as Liver Disease.
Bronchitis, Apoplexy, classify as Apoplexy.
Heart Disease, Child-birth, classify as Heart Disease.
Phthisis, Child-birth, classify as Phthisis.
Pregnancy, Uræmia, classify as Uræmia.
Pregnancy, Pneumonia, classify as Pneumonia.
Child-birth, Pneumonia, classify as Pneumonia.
Abortion, Sepsis, classify as Puerperal.
Abortion, Hæmorrhage, classify as Abortion.
Paralysis, classify as Hemiplegia.
Chronic Bronchitis, Acute Pneumonia, classify as Bronchitis.
Spinal Diseases, classify as Diseases of Organs of Locomotion.
Tabes Mesenterica, Pneumonia, classify as Tabes.
Scarlet, Child-birth, classify as Scarlet.
Rickets, Pneumonia, classify as Rickets.
Enteric, Influenza, classify as Enteric.
Emphysema, Bronchitis, classify as Emphysema.
Acute Eczema, Pneumonia (in an infant), classify as Eczema.
Cardiac Asthma, classify as Heart Disease.
Pneumonia, Laryngitis, classify as Pneumonia.
Morbus Cordis, Alcoholism, classify as Alcoholism.
Heart Disease, Asthma, classify as Heart Disease.
Measles, Diphtheria, then class under disease of longer duration. If no duration given then first named.
Bright's, Apoplexy, classify as Bright's.
Diarrhœa, Pneumonia, classify as Pneumonia.
Diarrhœa, Bronchitis, classify as Bronchitis.

STATISTICAL EVIDENCE OF THE HEALTH OF COMMUNITIES.

Estimates of the general health of a community are usually based on a consideration of the following :—

(i) General Death-rate.
(ii) Zymotic ,,
(iii) Infantile ,,
(iv) Phthisis ,,

(v) Mean age at Death.
(vi) Probable Duration of Life.
(vii) Expectation of Life.

(i) *The General Death-rate,* especially if corrected for age and sex, is a fairly good criterion. It is liable to be misleading where the population is small, and if not corrected for sex and age. Another source of error is the uncertainty of the population towards the end of an intercensal period ; further, especially if the population is small, the death-rate is liable to great fluctuations by reason of the occurrence of epidemics which have no known relation to sanitation.

(ii) *The Zymotic Death-rate* is really a somewhat uncertain guide. A high death-rate from certain zymotics *e.g.*, Diphtheria, Enteric, Typhus, and Diarrhoea may imply a defective sanitary condition. Typhus almost certainly does, but on the other hand, some of these may be due to purely temporary causes arising outside the town altogether, *e.g.*, infected milk and water or oysters or uncooked vegetables. Further, Small-pox, Measles, Whooping Cough and Scarlet Fever do not, as a rule, appear to be influenced by defective sanitary conditions. It must not also be overlooked that deaths due to protracted sequelæ of acute specific diseases (zymotics) are frequently erroneously credited to secondary and not the true primary cause, *e. g.*, Bronchitis and Pneumonia following on Whooping Cough and Measles.

The prevalence of zymotic diseases varies according to the number of susceptible children in it, and this fact must also be taken into consideration.

(iii) *The Infantile Mortality* is by some regarded as a reliable test of the sanitation of a place, as migration does not affect the result much, but (it is often observed) that the infantile death-rate is high in towns with a low general death-rate. The rate is influenced by so many factors that it cannot be considered a very safe index. Whooping Cough, Measles, prematurity, ignorance and want of care on the part of the mother, combined with, in many instances, practically compulsory absence of the mother at work all day in the fields or factory, all influence the infantile mortality. So also does parental alcoholism. Yet these causes cannot be said to directly reflect the sanitary condition of a town. On the other hand, epidemic Diarrhœa, which is a very fatal disease of infancy, does imply defective sanitation

In appraising the value of the infantile death-rate as a criterion, one must analyse the cause of the mortality.

(iv) *The Phthisis Death-rate.*—A high death-rate from Phthisis is generally indicative of defective sanitation in dwelling houses, workshops, public buildings and places of public resort, combined with ignorance and poverty. These two latter play a much greater part than they have been credited within the past.

The influence of modern methods of travel in trains and tramcars on the spread of the disease must not be lost sight of.

Meat and milk of infected animals also play a part.

(v) *The Mean age at Death* is obtained by adding up the ages of all those who have died, and dividing by the number of deaths. As a criterion it is of little value as it is influenced by the infantile mortality, which, if excessive, lowers the mean age at death, and it is also influenced by the age and sex distribution of the population.

(vi) *The probable Duration of Life* is the age at which exactly half of any given number of children will have died. It can only be obtained from a Life Table and is of no very great value.

(vii) *The Expectation of Life* at any age is the average number of years which a person of that age may expect to live.

The expectation of life at birth is known as the mean duration of life, whereas the expectation of life at all other ages than birth is known also as the mean after life-time.

The expectation of life is obtained from a Life Table and is the true measure of the vitality of a community.

In the absence of a Life Table, we can calculate the expectation of life for any age between 25-75 by the formula of Willich.

Let x=Expectation of life, a=Present age, then $x=\frac{2}{3}(80-a)$;

Or, by Farr's method from the birth and death-rates—

$$\text{Expectation of life at Birth} = \frac{2,000}{3D} - \frac{1,000}{3B}$$

The Comparative Mortality Figure.—If the corrected death-rate in each town be compared with the recorded death-rate at all ages in England and Wales taken as 1,000, we get a number known as the comparative mortality figure, or expressed in another way, after correcting the gross death-rate of a town for age and sex, the same number of people that gave 1,000 deaths in England and Wales gave—*?* for that particular town.

METHOD OF DEATH REGISTRATION IN BOMBAY CITY.

Bombay City is divided into seven Wards (A to G), each Ward being in charge of a Deputy Health Officer. These seven Wards are divided into ten districts, Wards B C and E having two district offices each on account of their size and density of population. Now each district (I to X) has an office which is in charge of a District Registrar and is used for the record of births and deaths in the district, and also as a free public Dispensary for the poor.

Working under each Registrar of Births and Deaths are two Sub-Registrars, qualified Hospital Assistants or Sub-Assistant Surgeons, and a Midwife qualified in most instances and under these Sub-Registrars are six Death Registration Ramoshis in each district.

The duties of these Ramoshis are to exercise a vigilant out-look for all funeral parties passing through their division and, when encountered, to approach the leader and ascertain certain particulars which must be entered on the annexed form which is in triplicate.

The form is printed in the Vernaculars and in English.

The information it conveys may be seen from the specimen copy.

No.__________

MEMO. OF DEATH.

मृत्युची नोंद.

This is to certify that the information regarding the
दाखला देण्यांत येतो कीं खालील मयतासंबंधी
deceased herein named is correct.
खबर बरोबर आहे.

Name__________

नांव__________

Sex__________

पुरुष किंवा स्त्री__________

Age__________

वय__________

Caste__________

जात__________

Date and hour of Death__________

मयत झाल्याची तारीख व वेळ__________

Place of Residence :—

राहण्याचें ठिकाण

(*a*) House__________

(अ)घर__________

(*b*) Street__________

(ब) रस्ता__________

(*c*) Ward__________

(क) वार्ड__________

____

*Death Registration Ramoshi No.*__________*Distt. No.*__________

मृत्यूची नोंद करणार रामोसी न०.__________डिस्ट्रिक्ट नं०.__________

One copy is given to the relatives, one to the District Registrar and the third is retained by the Ramoshi. The District Registrar (or Sub-Registrar), on receipt of this information, visits the deceased's house and ascertains the history of illness from the relatives or from friends, or he may perhaps obtain a death certificate from a medical man, or, in the event of having received information of the death before disposal of the corpse has taken place, he may be able to obtain a certificate from the medical man or may view the body.

It must be particularly noted that the slip given by the Ramoshi is in no way a death certificate ; it merely records certain statements as to age and more particularly the address which the Ramoshi must verify.

The verification of the alleged cause of death lies with the District Registrar, after consulting the relatives and interviewing the medical attendant.

In regard to those bodies which reach the cemetery without a Ramoshi's pass, the cemetery clerk, who is a qualified Hospital Assistant, makes certain enquiries from the relatives and enters the answers in the following form which he forwards to the District Registrar early next morning.

The District Registrar proceeds to the house as before and endeavours to ascertain the cause of death.

In the event of the cemetery clerk being suspicious in regard to any body brought for disposal, he is empowered to refuse permission to dispose of or remove the corpse until he has communicated with the Police.

Report of Death in the City and Island of Bombay.

Serial Number ______________

Date of Death ______________

Abode
District ______________
Sub-District ______________
Ward No. of house ______________
Street or Wadi ______________
No. of house in Street or Wadi ______________

Duration of residence in Bombay.
Years ______________
Months ______________
Days ______________

If a stranger to Bombay, or lately arrived, where from ______
Village ______________
Taluka ______________
District ______________

Name (and surname if any)

Sex

Race, caste or nationality

- Age .. ..
  - Years
  - Months
  - Days
  - Hours
  - Still-born

Occupation or profession of Deceased or Family

- Place of Birth
  - If in Bombay ..
    - District
    - Street or Wadi
    - No. of house
  - If out of Bombay
    - Village
    - Taluka
    - District

Country to which family belongs

Cause of death

- Duration of Disease .. ..
  - Years
  - Months
  - Days
  - Hours

Name of the Medical Attendant

Residence of do.

- Place of Disposal of Dead, No.
  - Buried
  - Burnt
  - Exposed

Signature of Informant.

Date of Information given :
191 .

District Registrar's Register No.

Registrar No. District.

CHAPTER XIV.

ROUTINE WORK OF THE SANITARY OFFICIAL.

In the chapter on 'Administration' the duties of the Sanitary Official in a large city in India have been laid down in detail.

The work of the Sanitary Officer, whether he be the Executive Health Officer of a large city, an Assistant or Deputy, or whether he fills the post of Sanitary or Conservancy Inspector, varies largely from that of a Sanitary Official in England.

THE HEALTH OFFICER IN ENGLAND AND INDIA.

In England the primary duties of the Medical Officer of Health are those concerned with the investigation and control of the spread of infectious disease. His work is purely advisory, and in no sense is he an Executive Officer as in India. He has to systematically inspect his district and be prepared to advise his authority on any matter affecting the public health. In many districts of England and Scotland, the Health Officer and the Sanitary Inspector have distinct duties to perform and each reports separately to his authority or committee, but subject to the instructions of that authority, the Health Officer may superintend the work of that Sanitary Inspector. He has certain duties to perform with regard to food and milk supply and offensive trades, and has from time to time to make reports on various matters which in his opinion may affect the public health, and the action taken by him or on his advice with regard to offensive trades, dairies, cow-sheds, milk-shops, factories and workshops, &c., school medical inspection and Tuberculosis. He must also compile and report on the vital statistics of his district. His sphere of work is, no doubt, wide, but owing to the stringency of the bye-laws, the pressure of public opinion and the desire on the part of the public of a Western city to have their surroundings in a sanitary condition, the work of a Health Officer in the West is more cut and dried, more defined and less liable to misconstruction and obstruction than that of his confrére in the East. Modern developments in sanitary science in the West have compelled the Medical Officer of Health to become more and more a specialist and to search for scientific and interesting work; but in India, while opportunities for special investigation and interesting work come daily to hand, he has rarely time to specialise, as he must be intimately in touch with the whole organisation of his department, which embraces multifarious duties unheard of in English cities.

The duties of the Health Officer of a city in India with a large population include the supervision of the conservancy and sanitary work and control of a large staff of subordinates and labourers, the registration of births and deaths and the enquiry into the cause of every death, the responsible work of investigating the cause of disease, enquiring into complaints from the public, and advising on plans of sanitary requirements of buildings. The carrying out of the duties set forth require that such an officer should be a highly trained and well-educated man with experience in public health administration, gained by previous responsible work in England and India, which will give him the confidence of the authorities and of the people; the salary must therefore be sufficiently high to attract the class of men with the qualifications above indicated.

The conditions of climate, habits and customs and religious susceptibilities of an enormous moving population, following different faiths, add to the difficulty of carrying out the administration of his Department.

In England the Health Officer does not supervise the conservancy work, has no labour to control and is not the Registrar of Births and Deaths, nor has he the cause of death of every person to be enquired into by the Health Department. Shortly, then, the work of the Health Department in Indian cities comprises the ordinary public health work of a Health Officer in England, and in addition the whole of the conservancy work of the city and the control of the labour staff, the regulation of trades, and the registration of births and deaths and the enquiring into the cause of every death and all outbreaks of Plague, Cholera, Malaria, Small-pox.

It is advisable in the interests of Indian cities that the conservancy work should be done by the Health Department, as it is intimately connected with its sanitary administration, and it is essential that a high standard of work should be aimed at: this can only be done by employing the right class of men to assist the Health Officer.

A Health Officer must possess an extensive and accurate knowledge of all matters pertaining to public health, and he should take advantage of every opportunity for examining personally the practical details of all questions that arise. The knowledge thus gained by actual inspection and practical experience will serve him in good stead when dealing with problems that daily occur; mere theoretical information gained from books is liable to lead him into difficulties.

Nothing should be taken for granted and second-hand information should rarely be relied on. He will meet with questions requiring much tact and discretion. Private and public interests often clash. Pressure may be brought to bear on him by interested parties and he may find himself in trouble unless he brings forward accurate information backed up by a straightforward and conscientious intention to do the right thing.

A great deal depends on the personality of the Health Officer. He must remember that he is dealing with those who consider they have, but do not really possess, that knowledge of technical subjects in which the Health Officer is an expert.

Discretion and tact are attributes that come naturally and are difficult to acquire, if not natural. In bringing forward questions of great importance to public health, he will often find himself opposed by conflicting opinions, interests and objections and difficulties; he may be defeated temporarily, but he must not give in and while bending to an adverse decision he should wait for a favourable opportunity to bring forward his suggestions again and again.

The Health Officer will have to meet in committee members of his council to consider questions relating to the public health of his district and he should be able to control his temper. Members of council consider themselves to a certain extent privileged to make statements that they would not dare to utter in their private capacity as citizens. A sense of fairness and justice to an official, as a rule, on the part of some of the members will defend him against what may be uncalled-for and unfair attacks. He will listen patiently to all argument and opinion, but he must have a firm guiding hand.

Most men prefer to be led rather than driven and the Health Officer must gain the confidence of the public and his sanitary authority, without which he will not be successful. He must not be in too great a hurry to push forward improvements or innovations, however keen he may be to see good results. Things "hurry slowly" in the East and municipal government in any country can never be accused of haste.

A Health Officer must keep before him a high standard; zeal in his work, careful consideration of his subject and the conditions of life surrounding it in the East will soon convince his authority that he can be relied on.

In order, therefore, for a Health Officer to properly perform his duties, he must have an intimate acquaintance with all the statutes, acts and bye-laws relating to his office; he should be thoroughly conversant with the principles of modern sewerage, drainage, disposal of sewage, water supply, ventilation of buildings and house construction and practically acquainted with the duties of the Inspector of Nuisances and the methods of conservancy system. He should have a knowledge of trades, articles of trades and manufacturing processes that are likely to be controlled by the Corporation. He must be thoroughly acquainted with the etiology of disease, with the appearance and symptoms of all infectious and tropical diseases, and must know the principles of hospital construction and administration. He must have a knowledge of bacteriology and parasitology and chemistry, although he will not have time for much research work. He must have a knowledge of vital statistics and be able to compile statistics and to deduce sound conclusions therefrom. He must have a knowledge of the methods of analyses of water, air and foods, although not always called upon to perform these analyses; he should understand meteorology, climatology and kindred subjects.

He must be a good organiser and administrator and have an enormous capacity for literary work and writing numerous reports which will be expected of him.

In addition to these qualifications he must be possessed of tact, discretion and good judgment, patience and perseverance, and he must be courteous and impartial in all his actions. These latter attributes are especially necessary in dealing with the population of India.

Sanitary students should take every opportunity of gaining practical knowledge. Reading books on sanitation and cramming up facts and figures may enable them to pass the examination but will not help them much when they have practical work to do. A six months' course of lectures and demonstrations without an earnest desire on the part of the student to see their practical application will be so much time wasted. A successful student is one who knows and can undertake what he inspects. He should therefore see carried into practice what he has learnt from books, as without this experience he will find himself up against some serious trouble when he comes to apply his book learning to everyday life. This is especially the case with the sanitary student in India.

The opportunities of gaining practical experience of modern sanitary methods applied to India are few but are multiplying rapidly.

In his visits of inspection to houses, stables, factories, workshops, or premises, wherever his duty may call him, he must conduct himself with discretion and tact. Persuasion and good address are valuable adjuncts to the Sanitary Official; he should by these means gain the confidence of the public, and although invested with important powers it is not always necessary to push them to the limits. Honesty, sobriety and straightforwardness, combined with good temper and knowledge of his work, will soon gain for him a reputation for reliability, without which he will be a failure. He will frequently meet with opposition and intrigues, temptation, false information and anonymous attacks against his character. Accusations of bribery and corruption are common. These can only be overcome by having the confidence of his superior officers and the public and their support.

CONSERVANCY INSPECTORS.

In India the work of the Conservancy Inspector and Sanitary Inspector may be combined or separate. In the case of the former official, his duties are chiefly to supervise labour staff, the cleansing of streets, privies, latrines and the removal of refuse. In India this is no light task, as on it depends the cleanly appearance of the city and to a very large extent the health of the people. It has already been pointed out that this work should be done by the Health Department as, if it is placed under the Engineering Department, the dual control is likely to lead to inefficiency and friction with a resulting effect on the health conditions of the city.

In the chapter on the Administration of Public Health Acts, the subject of duties of officials has been gone into in detail. The way these duties are carried out must depend largely on local circumstances and surroundings and the financial aspect. The great and persistent object to be kept in view is supervision, *systematic, strict and everlasting*, without which no subordinate officials or labour staff can be kept up to their work.

The Conservancy Inspector will have to face difficulties with his labour staff; strikes, corruption, bribery and false information in connection with the food supply of the bullocks, stores, coal, oil, &c., and complaints from the public. He must be a strong man mentally and physically, for he will have many difficulties to contend with.

ROUTINE WORK OF SANITARY INSPECTORS AND THE WORKING OF THE SANITARY PROVISIONS OF THE CITY OF BOMBAY MUNICIPAL ACT.

The actual methods of work of a Sanitary Inspector in different places will differ in degree only, varying with the size and importance of the towns and the powers given him under the local Acts and the financial position of the Municipalities. In England the duties of the Sanitary Inspector are rigidly laid down and in the larger cities and presidency towns of India some such instructions and methods of work should be followed. In the City of Bombay the following is the procedure adopted.

During the daily morning and afternoon rounds entry is effected by the Sanitary Inspector into or upon a building or land, (under the powers delegated to him under Section 488 of the Act) and a regular inspection (under Section 374) is made of premises to ascertain the sanitary condition thereof.

While inspecting the premises, first of all an inspection of the surroundings and outside of the building for human habitation is made and notes are taken on the following points :—

(*a*) The width of the road and the surrounding open spaces.

Any action, if necessary, is taken by the Engineering Department.

(*b*) The height of the building.

Any action, if necessary, is taken by the Engineering Department.

(*c*) The condition of the open spaces, gullies and sweeper's passages.

If the open space comprises vacant land in a filthy condition, action against its owner is taken under Section 377 to clean it. If the gullies are found in a dirty condition, the Conservancy Inspector concerned is requested in writing to have them cleaned and flushed.

If the pavement of a gully is broken, action under Section 257 to have it repaired is taken by the Health Department, and if heavy repairs are needed or a gully is *kutcha* and requires remodelling, the Drainage Department is requested by letter to have proper repairs executed, pavement made or the gully remodelled.

When a house-drain is found choked, the attention of the House Drain Inspector is at once drawn either by telephone or in writing to relieve the choke, and he in his turn, if he finds that the choke in the house-drain is due to a choke in the street connection, at once requests the Drainage Department to relieve the choke from the street connection.

(*d*) Whether there is any ditch, pool of water, quarry-hole, tank, well or low land in which the storm or waste water stagnates. Action under Section 381 is taken by the Health Department to fill up such ditches, tanks, pools, etc.

(*e*) The condition of the sanitary fittings fixed on the outside of the external walls. If the sanitary fittings are found, on inspection under Sections 253 and 256, to be out of order or broken, action under Section 257 is taken by the Health Department to repair, renew and lengthen such waste-water or discharge pipes, cistern-heads, or cleaning caps, etc.

If any of the waste-water pipes or a gully trap on any premises is found choked by the Sanitary Inspector, the Conservancy Inspector concerned is requested by telephone or in writing to get such waste-water pipes cleaned and choke removed from the gully traps.

(*f*) The plinth of the house.

(*g*) The condition of the flooring, side and partition walls of the roof and the materials of which they are made.

(*h*) The means of light and ventilation of rooms.

(*i*) Internal open space or *chowks.*

(*j*) The area of each room and the number of inmates thereof.

If the plinth is found low, *i. e.*, two feet below the level of the road, the flooring is found earthen or damp and not paved with stone slabs or made of impervious materials, the walls are of split bamboos plastered over with mud and dung, or of wooden planks or are saturated with moisture and dampness ; the roof is low and of inflammable materials, the rooms are dark and ill-ventilated owing to the means of light and ventilation being found insufficient, inefficient or defective : such a house is considered insanitary and unfit for human habitation, and is reported to the Municipal Engineering Department with a request to take necessary action under Section 378 to either declare the house U. H. H. or so improved as to render it fit for human habitation. If the area of a room is found less than 100 square feet as required by law, the attention of the Engineering Department is drawn to it by letter to dispeople the room, and in the event of its being found overcrowded, action under Section 379 A. is taken by the Health Department.

(*k*) The soundness or stability or otherwise of the building. If the house is observed to be in a dilapidated or ruinous condition, it is at once reported to the Engineering Department for necessary action under Section 354 of the Act. Houses which are abandoned or unoccupied are similarly reported to the Engineering Department for action under Section 376.

(*l*) Water supply from a well or from a Municipal main ; the position of the tap and the pipes. If the position of the water tap is found near the privy or in an objectionable place, or the tap is found out of order, or the service pipe is laid in the open channel drain or is bathed in sewage, or any direct water connection is found with the flush tanks in the water-closets or inside the privies, the Water Department is requested by letter to take necessary action under Section 273-A of the Act for their removal from the objectionable position.

(*m*) Whether or not there is a well inside the house. Sample of well water is sent for analysis. If the well water is found smelling foul, or requires to be cleaned, action under Section 381 is taken by the Health Department or, if the well requires to be closed or covered, a reference is made to the Malaria Branch of the Health Department to take action under the same Section.

(*n*) The situation of bathrooms or *nahanis* and their drainage arrangements.

If the bathrooms or *nahanis* are found not properly drained or trapped, a letter is written to the Drainage Department to take necessary action in the matter. If they are found insufficient, action under Section 248 (1) is taken by the Health Department.

(*o*) Sanitary conveniences. Whether the house is served with a basket privy or a privy on the intermediate water carriage system or a water-closet on the full flushing system. Number of seats, their condition, sufficiency or otherwise, whether properly detached or not, whether dark or ill-ventilated and whether properly drained and trapped.

If on inspection (under Sections 253 and 256) a privy or a water-closet is found in a dilapidated and broken condition, the seats being broken and the beds of the traps below the surface level of the drain, or the drainage is defective or is not in good order or condition, action for its entire removal is taken, under Section 257, by the Health Department.

If it is dark and not well ventilated, action under the same Section is taken by the Health Department to ventilate the same. If the beds and seats are broken and if there is no proper receptacle in the trap of a privy on basket system, action is taken under the same Section of the Act for the necessary repairs and the provision of a receptacle. If, in case of a privy on the intermediate water carriage system or a water-closet on the full flushing system, the apparatus and appliances require repairs and to be put in working order, the Drainage Department is requested to take action, and in case of urgent necessity, action is taken under Section 257 by the Health Department also. If the privy accommodation is found insufficient *i.e.*, if it be not in the required proportion of one seat to a set of every five rooms—action for such additional number of seats required is taken under Section 248 (1) (*a*). If structural or other alterations in the existing water-closet, privy or urinal accommodation are found necessary, action under clause (*b*) of the same Section is taken. If a privy on basket system is found on sanitary grounds objectionable, action for converting it into a water-closet is taken under clause (*c*) of the same Section of the Act. If a privy on basket system or on the intermediate water carriage system is found not properly detached as per Section 250 (1) (*a*) and it is attached to the main building, action under Section 249-A (*b*) is taken to detach it, or to close it up and to provide in lieu thereof a water-closet on the full flushing system under clause (*a*) of the same Section. A privy on basket system if found exposed to the view of persons living in the neighbourhood or passing by, action is taken under Section 250 (*b*) of the Act. If any action as regards detachment, ventilation, flushing apparatus and other appliances in respect of a water-closet is found necessary, the attention of the Engineering Department is drawn to it to take action under Section 251 to remove the defects. If a privy or water-closet is found to have been built directly over or directly under any room or part of a building other than another privy or water-closet or a bath-room or a terrace, the attention of the Engineering Department is drawn to it for action under Section 251-A (*a*). No new privy or water-closet is allowed under Section 251-A (*b*) of the Act within a distance of 20 feet from any well, spring, tank or stream liable to pollution, and if any such privy or water-closet is found, action under Section 381 is taken by the Health Department to fill up such well, tank, etc. Action is also taken under Section 372 (*f*), under the recent orders of the Municipal Commissioner, where the water-closet pans or receptacles are found to be in such a state for want of flushing as to be offensive or injurious to health.

(*p*) Whether any animals such as goats, cows, bullocks, etc., are kept inside the house. If any are found in a house, action is taken against the owner or owners of such animals under Section 384 (*b*) of the Act by the Health Department.

(*q*) Any case of sickness or birth noted. If any case of sickness, infectious disease, or of a child-birth is noticed, it is at once brought to the notice of the District Registrar concerned.

For want of proper and suitable housing accommodation for the poor and low class people, such as Wagrees, Mahars, Kathiawadees, etc., a number of them have to accommodate themselves in huts and sheds built of inflammable materials on any available piece of open land in any street. These structures are all insanitary and unfit for human habitation. The Engineering Department being delegated powers under Section 380 of the Act to remove these huts and sheds, the attention of that Department is called in writing to this class of insanitary dwellings.

The License Department, taking action under Section 394 (*c*) of the Act, at the instance of the Health Department, indirectly compels the owner to remove the sheds that are erected on open land for stabling bullocks, horses or buffaloes if these sheds have not been licensed for the purpose.

Milch Cattle, Horse and Bullock Stables.

Any person who intends to build any of these stables has to make a written application to the Health Department. Such application is to be accompanied by a block plan in duplicate, showing the site of the proposed stable and its surroundings, its drainage arrangements proposed, and other necessary adjuncts. In reporting upon the application, the Sanitary Inspector notes the following three points, as in the case of applications for the establishment of factories etc., *viz.*, (1) the suitability of the site proposed; (2) whether the locality is open or thickly populated, whether suitable or not for the purpose and whether or not it will prove a nuisance; (3) the distance from the public road and from the nearest dwelling house. If the site is approved and the proposals made are found in accordance with the Bye-laws, as regards open spaces around the sheds, length, width and height of the sheds, pavement of the flooring, drainage arrangements, washing place for animals, dung receptacle, place for storing hay and the feed of animals, quarters and privy accommodation for *gowlis*, syces, cart drivers, etc., the Health Officer (or his Assistant), after visiting the place, recommends to the Municipal Commissioner to grant the application, on condition that the requirements suggested by the Health Department are carried out.

Licensed and unlicensed milch-cattle, horse and bullock stables.—If, on inspection of the licensed stables, any of them is found over-crowded, or any repairs to the flooring of the stalls, or to the washing place or dung receptacle or pavement are found necessary, a reference is made to the License Department for action under Section 394 and under the terms and conditions of the License. If a stable is found in a dirty condition for want of regular removal of dung or stable refuse, action under Section 377 for their removal is taken, or if a large accumulation of stable refuse and dung is found, action under Section 372 (*f*) is taken by the Health Department against the owner or the licensee, as the case may be.

Bake-houses and Aerated Water Factories.—Bake-houses are licensed, under Section 394, on their complying with the requirements demanded by the Health Department. If a bake-house is conducted without carrying out the Health Department requirements, the License Department is requested to take the necessary action ; the same is done in respect of aerated water factories. For the limewashing of bake-houses, aerated water factories, public eating houses, theatres, etc., action is taken by the Health Department under Section 375 of the Act.

Eating houses, tea and coffee shops.—Action against such of these places as are licensed is taken by the Police Department, if any of them is conducted without carrying out the requirements demanded by the Health Department and without the "no objection" certificate.

If houses, privies, water-closets, etc., are found in a dirty condition and walls smoke-begrimed, or any case of or death from an infectious disease occurs in a house, action under Section 375 for the lime-washing of such buildings is taken by the Health Department.

Action in respect of a milk-shop is taken by the Health Department. Samples of milk are regularly sent for analysis and the milksellers are advised as to the necessity of keeping milk cans and other vessels in a clean condition, and not to expose the milk but keep it in a can having a proper air-tight cover.

If a *Dhobi Ghat,* or a place for washing clothes by washermen in the exercise of their calling, is found to be established without the sanction of the Municipal Commissioner, or without carrying out the requirements demanded by the Health Department, action under Section 397 (1) of the Act is taken by the Health Department.

Though powers under Sections 414 and 416 are not delegated to Sanitary Inspectors, they have to be exercised by the Sanitary Inspectors in destroying meat, fish, vegetable or other article of a perishable nature, which may be found diseased, unsound or unwholesome for human food or for medicine as the case may be.

Samples of articles of food, such as flour, oil, tea, coffee, aerated waters, butter, vinegar, alcoholic beaverages, drugs, soaps, etc., are purchased and sent to the Municipal Analyst for analysis.

Any animals found tethered in a street or a public road are handed over as stray animals, under Section 316 of the Municipal Act, to the nearest Policeman, who removes them to the Cattle-pond.

Action under Section 377 is taken by the Health Department against the owner of open land overgrown with rank and noisome vegetation or on which refuse or *cutchra* is found. Persons caught while throwing *cutchra,* refuse, etc., on public roads are prosecuted by the Health Department under Section 372 (*e*).

Prosecution under the Ghee Act II of 1899 is undertaken by the Health Department when a sample of ghee analysed is found adulterated.

Public latrines and urinals.—An inspection is regularly made and action taken to keep them clean.

Every person, who intends to newly erect a building, or to re-erect any building pulled down to the plinth, or any frame building of which only the frame-work is left down to the plinth, or to convert into more than one dwelling house any building not originally constructed for human habitation or to convert into more than one dwelling house a building originally constructed as one dwelling house only, has to give, under Section 337, notice of his said intention in a prescribed form, as per Section 344, to the Municipal Executive Engineer and to submit, under Section 338, a block plan in duplicate showing the position of such building in relation to the adjoining properties, the width and level of the street in front or at the rear, the intended line of drainage, the sites and positions of the proposed privy or water closet and washing places, means of ingress and egress and light and ventilation, &c. Such a plan should be prepared by an Architect or a Licensed Surveyor, under Section 339 of the Municipal Act. One of the two copies of such plans is then sent by the Engineering Department to the Drainage Department for remarks as regards the drainage arrangements proposed, and the other copy to the Health Department for remarks as to the site or sites of the proposed privy, water-closet or washing place, and on other sanitary points. The Sanitary Inspector on receiving the plan finds out the building site from the block plan and then proceeds to inspect the sites of the proposed privy or water closets and washing place, and their number, under Sections 246A and 247 of the Act.

If the site or sites proposed for a privy or water-closet or a washing place be found objectionable on account of its or their being close or directly opposite to a living room or a dining or cook-room of the adjoining house or houses or near the windows of a bed-room of other houses adjoining, or abutting on a public street or a passage, such site or sites is or are altered and marked by the Sanitary Inspector on the plan. While returning the plans to the Engineering Department, the Health Department draws its attention to the site or sites so altered in the plan and specifies the number of privy seats required and the kind and type of the privy or water-closet that should be built. The Engineering Department has to return the plan duly approved or disapproved to the party within 30 days, after which the party commences the building work, in accordance with the provisions of Section 348 of the Act and the Building Bye-laws. The Sanitary Inspector goes every month or fortnight to watch the progress of the building work and to see whether or not the requirements demanded by the Health Department are being carried out during the construction of the building. When the building is completed, the Engineering Department grants a Completion Certificate to the party, if the Health Department has no objection. If any of the requirements, demanded by the Health Department at the time of passing the plans, are found not to have been carried out, then the grant of such a certificate is not recommended, and the Engineering Department takes action against the party under Section 353 or 353A, for not carrying out the work according to law, and for occupying the building without permission.

Every person who intends (*a*) to make any addition to a building, or (*b*) to make any alteration or repairs to a building not being a frame-building, or (*c*) to make any alterations or repairs to a frame building, or (*d*) to remove or reconstruct any portion of the building abutting on a street which stands within the regular line of such street has to give to the Municipal Engineering Department notice under Section 342 in a prescribed printed form (under Section 344) specifying therein the position of the building in which such work is to be executed, the nature and extent of the intended work and the name of the person who will supervise its execution. If any notice given under Section 342 does not supply all the information, which the Executive Engineer deems necessary to enable him to deal satisfactorily with the case, he, within 30 days after receipt of the said notice, asks the party concerned to furnish a plan of the building and of the intended new work. On the party submitting such a plan the same procedure is followed as described in the preceding paragraph.

If a plan is submitted by a party to the Engineering Department for a building for human habitation or a factory, intended to be erected in a cemetery or a graveyard no longer in use, the Health Department has, under clause (*c*) of Section 348 of the Act, to be satisfied before the foundation of any such building is constructed that all the excrementitious matter or the carcasses of dead animals and other filthy or offensive matter have been properly removed to the satisfaction of the Health Department.

Every person who desires to establish any factory, such as a flour-mill, an oil-mill, a printing press, an aerated water factory, a cabinet factory, &c., and in which it is intended that steam, water or other mechanical power is to be employed, has to make a written application accompanied with a block plan in duplicate showing therein the site of the engine, its horse-power and the drainage arrangements, etc., of the factory. In reporting upon such applications, the Sanitary Inspector has to note (1) the suitability or otherwise of the site proposed; (2) whether the locality is open or thickly populated, and whether suitable or not for the purpose and whether the factory will prove a nuisance; (3) the distance from the public road and from the nearest dwelling house. If the site is disapproved on account of its being so situated that it would cause or prove a nuisance, the application is rejected after the place has been seen by the Executive Health Officer or his Assistant. If the site is approved, then the usual requirements as regards the flooring, drainage arrangements, sanitary conveniences, etc., the height of the chimney or an exhaust pipe, means of light and ventilation and the means of ingress and egress are demanded. As far as practicable, factories are not allowed under dwelling rooms or in a building the upper floors of which are occupied for human habitation. No part of the machinery is allowed to be attached to any part of the building, as a safeguard against an accident.

While inspecting (under Section 396 of the Act), if it is observed that a newly established factory, workshop or workplace is worked with steam, water, oil engine or other mechanical power, without the previous written permission of the Municipal Commissioner, and without carrying out fully the requirements of the Health Department, action is taken by the Health Department under Section 390 (1) against the offender or offenders.

If, on inspection of a factory (under Section 396), a place of public resort, market, or a place in which persons exceeding 20 in number are employed in any manufacture or business, or as workmen or labourers, it is found that such premises are without privy or urinal accommodation, action is taken by the Health Department, under Section 249 of the Act, to enforce the provision of the necessary conveniences.

In the case of smoke nuisance from a factory, workshop or workplace or mill, action is taken under Section 391 of the Act by the Health Department. Since the passing of the Bombay Smoke Nuisances Act (VII of 1912) the Factory Inspector appointed by Government takes the necessary action in this direction.

ACTION BEFORE THE MAGISTRATE.

The procedure that is adopted in taking action under Sections 257, 377, 375 and 250 (*b*) is as follows :—

When an offence is noted, or any such defects as described above are found to contravene the provisions of these Sections, an Offence Sheet is made out by the Sanitary Inspector (entering in column 4 thereof the nature of offence and the requirements necessary to remedy it) and submitted to the Deputy Health Officer's office, after being registered in the Ward Office. If the offender is a J. P. or a man of rank or position, before a notice is issued a letter is addressed to him by the Deputy Health Officer's office, drawing attention to the nature of the offence and requesting him to carry out the requirements copied out from column 4 of the Offence Sheet. In case of other offenders, a printed notice—under Section 257 (1) or 377 or 375 or under all these three Sections—is prepared in the Deputy Health Officer's office and issued under the signature of the Deputy Health Officer, under Section 68 of the Municipal Act, as empowered by the Commissioner in this behalf. The notice though not signed but stamped with the *fac simile* of the signature of the Deputy Health Officer is deemed to be properly signed and considered legal, under Section 487 (1).

The notice thus prepared is sent in duplicate, with the Offence Sheet, to the Sanitary Inspector for service on the party concerned. The Assistant Inspector or Sub-Inspector, who holds the authority from the Commissioner under Section 483 of the Act to serve notices and summonses, takes the notice to the residence or the place of business of the person against whom it is issued and gives or tenders it, as required by Section 484 (*a*), to the party concerned personally. If after repeated efforts the party named in the notice is not found at home or at his place of business and personal service not be effected, the notice is given or tendered to some adult male member or servant of his family, as per clause (*b*) of Section 484. If the party resides somewhere in the suburb or elsewhere, the notice is served upon him by post under a registered cover, as per clause (*c*) of Section 484. If the party keeps in hiding and avoids the service of the notice, permission of the Deputy Health Officer is obtained to affix the notice on some conspicuous part of the building or land, if any, to which the same relates, as per clause (*d*) of Section 484 of the Act. When the service of the notice is effected by the Sub-Inspector or the Assistant Inspector, he makes the necessary endorsements under his signature in the form printed on the reverse of both the original and the duplicate notice. The original is then handed to the party concerned and the duplicate brought back with his signature thereon as an acknowledgment. In the body of the notice time is prescribed in which the party should carry out the requirements mentioned therein. After the expiry of the notice, the Sanitary Inspector visits the premises and checks all the requirements mentioned in the notice. If all the requisitions have been fully complied with, the duplicate notice is endorsed and returned to the Deputy Health Officer's office to be filed. If, on the other hand, the notice is partly complied with or is not complied with at all, the duplicate notice is so endorsed and returned to the Deputy Health Officer's office, where an order is passed by the Deputy Health Officer to prepare a summons. Summons is then prepared in duplicate, by the Notice and Summons Clerk in the Deputy Health Officer's office, on forms supplied by the Presidency Magistrate. Simultaneously, information of the Deputy Health Officer is prepared in a printed form and also a Charge Sheet. The information is then filed before the Magistrate on the next available Court day. The Magistrate passes an order thereon for the issue of process, and the summons prepared in the Deputy Health Officer's office is presented to the Judicial Clerk of the Court, who signs it for the Magistrate. The summons is then sent by the Court to the Police Superintendent concerned, who sends it with a constable, who is told off on summons duty, to the Sanitary Inspector. The latter directs his Assistant, who is authorised to serve Notices and Summons, to accompany the constable to the party's residence to identify the party. The service of the summons is effected in the same way as that of the notice as per Section 484 of the Act. If the party evades the service of the summons, an order is obtained from the Magistrate for 'substituted service,' and the summons is posted on some conspicuous part of the building or land to which it relates. If, between the time of the application for the summons and its issue and service, it is found that the party has carried out all the requirements mentioned in the notice, the service of the summons is withheld and, after the Sanitary Inspector has satisfied himself that the work has been done satisfactorily, the case is taken as "complied with" before the service of the summons, and the case is withdrawn on the Court day, under Section 517 of the Municipal Act. A day previous to the return-able date of the summons the Sanitary Inspector again visits, with his Assistant, the premises in respect of which the summons is served and checks the notice, noting in his "Summons Book" how far the requisitions of the notice have been complied with. These notes are subsequently copied in the office Charge Sheets.

On the Court day the party, on whom the summons is served, appears in person or by a pleader, or by his agent holding the Power-of-Attorney, to answer the charge in the Magistrate's Court. The fair Charge Sheet is placed before the Magistrate and the office Charge Sheet remains in the hands of the Deputy Health Officer, who reads out from it the offence with which the respondent is charged. If the accused has carried out the work, after the service of the summons, the case against him is taken as "complied with," and the party is warned and discharged by the Magistrate. If the accused has not done anything to comply with the requisitions of the notice and pleads "guilty," he is convicted and fined under Section 471 of the Municipal Act. If he pleads "not guilty," the Magistrate directs to lead the evidence and on taking the evidence of the Sanitary Inspector or the Deputy Health Officer, decides the case as he thinks fit by inflicting a fine or by warning and discharging the accused.

The fines are paid in the Court the same day, and the total amount of fines recovered is paid by the Court into the Municipal Treasury. Those who have no money to pay the fines there and then, are allowed a week's time, and in case of default, Distress Warrants are issued by the Court and executed by the Police, with the assistance of a Sub-Inspector or an Assistant Inspector from the Municipality on the presentation of the Warrant. If the defaulter refuses to pay the fine recoverable from him the Police seize his goods and household furniture, etc., and recover the amount of fine by disposing of the goods by an auction sale.

If after the service of a summons the party fails to appear before the Magistrate, a Warrant is ordered against him by the Court and the case is adjourned to the next Court day. The Warrant signed by the Magistrate is then executed by the Police, with the assistance of the Sub-Inspector, who has served the Summons, and the party is then released on bail.

A week or ten days after the conviction of the party, the Sanitary Inspector again visits the premises with a view to find out if the party has since done anything to carry out the requirements mentioned in the notice. If he has, no further action is taken. If he has not, then a report to that effect is made to the Deputy Health Officer, who issues an after-conviction notice, and the same procedure as described above is repeated, and the party failing to comply with the after-conviction notice is punished under Section 472, wherein a daily penalty is prescribed for each day the party continues to offend by neglecting or failing to comply with the requisitions lawfully made upon him.

The following is the procedure adopted in taking action under Sections 248 (1) (*a*), (*b*), (*c*), 249, 249-A (*a*), (*b*).

Section 248 (1) :—

The Sanitary Inspector inspects a building and counts the number of rooms on all the floors and takes a census of the occupants thereof. He then counts the number of privy seats provided on the premises and takes a note of all these. If the premises are without privy accommodation or the number of privy seats is insufficient, an Offence Sheet is made out accordingly by the Sanitary Inspector, to call upon the owner to provide privy accommodation or an additional privy of as many seats as would be necessary in the proportion of one seat for every set of five rooms or twenty persons. The Deputy Health Officer then addresses a letter to the owner concerned to provide such additional privy or water-closet accommodation as may be prescribed, or to urge his objections, if any, in fifteen days. If the letter remains unreplied for a fortnight, a reminder is sent to the party. In the meantime, references are made by letter to the Municipal Engineering, Water and Drainage Departments as regards structural alterations that would be necessary for the location of privy seats, the pressure of water and the drainage arrangements of the premises. On receipt of replies, a letter is addressed to the Municipal Commissioner (with copies of replies from the Departments, and of the party's letter, if any, urging his objections) to apply to the Standing Committee for their approval to a notice being issued. After such approval is given, a notice is prepared in the Deputy Health Officer's office, and the same procedure as detailed above is adopted thereafter in taking further action.

In the case of action under clause (*b*) of Section 248 (1), the same procedure as above is observed.

For action under clause (*c*) of Section 248 (1), the Sanitary Inspector has to note and report the insanitary features and the grounds on which the existing privy is considered objectionable and requires to be converted into a water-closet. An Offence Sheet is submitted by the Sanitary Inspector and the rest of the procedure is the same as above.

Section 249 :—In case of action taken under this Section, the procedure is the same as under Section 248 (1).

Section 249-A. :—In taking action under this Section, the procedure is the same as in respect of Section 248, with the only exception that no reference is made in this case to the other Departments of the Municipality.

For action under Section 381, the first step is to take a sample of water for analysis from a well, tank, a ditch or a pool. After the receipt of the result of the analysis from the Municipal Analyst, an Offence Sheet is prepared by the Sanitary Inspector and submitted to the Deputy Health Officer's office to issue a notice to clean or fill up such a well, tank, ditch or pool. The Deputy Health Officer prior to the issue of the notice addresses a letter to the party to carry out the requirements mentioned in the Offence Sheet, failing which an application is made to the Municipal Commissioner to get the Standing Committee's approval to a notice being issued under this Section. On obtaining such approval, a notice is prepared in the Deputy Health Officer's office and sent to the Municipal Commissioner for his signature and served on the owner and the same further procedure is then adopted as above.

In case of action under Sections 372 (*e*), (*f*), 384 (*b*) and 390 (1), no notices are issued, but a direct summons is applied for on the submission of an Offence Sheet by the Sanitary Inspector. The summons is then served and further proceedings are taken in the Court as described above. No after-conviction action is admissible in case of action taken under Section 390 (1).

The procedure in taking action under Sections 379 and 379A is as follows :—

The Sanitary Inspector takes a rough census of all the rooms of a house or a *chawl*, against which it is intended to take action for overcrowding, and if he finds that the place is overcrowded, he prepares under Section 379 a notice which, after being signed by the Deputy Health Officer, is served, with a form of certificate, on the party concerned, who has to fill up the form and return it to the Deputy Health Officer within seven days. If the party fails to do this, a complaint is filed before the Magistrate under Section 379, and he is summoned before the Court for non-compliance. The Magistrate then passes an order or convicts and fines the defaulter under Section 471. If the party furnishes the required information, the Sanitary Inspector visits the premises with the certificate and verifies the measurements of each room and takes an independent census of each room, either early in the morning or after 9 p.m. If on verification the statement given by the party does not agree with the result of the census taken, the matter is reported to the Deputy Health Officer, who files an information (in the same way as described above) before a Magistrate, who orders the issue of a process. The party then appearing in Court, the Magistrate gives an order to abate the overcrowding in ten days' time, under Section 379-A of the Municipal Act. Failure to comply with this order renders the party liable to the penalty prescribed under Section 471 of the Act.

As a rule, action is taken generally against the owner of a house and in his absence against the person who receives the rent of the said premises, or who would be entitled to receive the rent thereof if the premises were let; against an agent or trustee who receives such rent on behalf of the owner; against an agent or trustee who receives the rent of, or is entrusted or concerned with, any premises devoted to religious or charitable purposes ; and against a receiver, sequestrator or manager, appointed by any Court of competent jurisdiction to have the charge of, or to exercise the rights of the owner of, the said premises, under Section 3 (*m*) of the Act.

Complaint of offences for which the Health Department has to take action should be made before a Presidency Magistrate within three months next after the commission of such offence under Section 514 (*c*).

If an offender under the Municipal Act declines to give his name and address, the Sanitary Inspector or his subordinate, under Section 522, asks for the co-operation of the Police who arrest the offender under Section 516 of the Act.

If any offender, placed before the Magistrate for contravening the provisions of any of the Sections of the Municipal Act or for not carrying out the requirements lawfully demanded of him, were to disown the liability and responsibility under Section 477 of the Act, or proves his inability to carry out the work for want of sufficient funds, he is let off under Section 500.

CHAPTER XV.

METEOROLOGICAL INSTRUMENTS.

Meteorology, or the science of the weather, which word in itself denotes the general condition of the atmosphere, and especially of that portion of the atmosphere near the surface of the earth.

In the pursuit of meteorology two duties present themselves, *viz.*, the accurate observation of various phenomena, *e.g.*, temperature, pressure, wind, humidity, cloud, &c., and secondly, the practical interpretation of the data obtained.

To be of practical value, all observations made in various parts of the world must be comparable and reduced to a common standard.

Temperature.

Temperature must be distinguished from heat—which is a thing, something objective—whereas temperature is a mere condition of a body temperately heated or cooled.

It is measured by thermometers, the principle actuating which being the expansion and contraction of certain bodies with change of temperatures. Liquids are best suited for ordinary purposes, as gases expand too much and solids too little to indicate small differences of temperature. Gases and solids are however used for temperature purposes.

Mercury and alcohol are the two liquids most commonly used; the former because of its low specific heat, equal expansion at different temperatures, its low freezing point, *viz.*, 37·9°F, and its high boiling point, *viz.*, 675·1°F; and alcohol is used because it does not freeze at the greatest known cold at atmospheric pressure.

For these reasons mercury is used for recording fairly high temperatures and alcohol for low ones.

A thermometer consists of a capillary glass tube of uniform bore, hermetically sealed at one end and blown out at the other into a bulb which is filled with alcohol or mercury, the expansion or contraction of which is measured by a scale marked either on the tube itself or the frame to which it is attached. There are four steps in the manufacture of a thermometer, *viz.*, (1) Calibrating the tube or dividing it into parts of equal capacity. (2) Filling the bulb or tube with mercury or alcohol and expelling all air by heat. (3) Curing, *i.e.*, laying aside the instruments for a year or so after they are filled and before graduating. This permits contraction of the glass and so prevents displacement of zero as, if graduated too soon after filling, thermometers read too high after a few months. Of recent years, however, this process of curing by laying aside has been obviated by means of the annealing oven in which the tube is rapidly cooled from a temperature of 320° F. to atmospheric temperature in 14 days. (4) Graduation. In order to mark off a scale of temperatures two points must be taken. These two points are zero and boiling point.

In England and America, zero is the temperature obtained by mixing equal parts of snow and Sal ammoniac. On the Continent of Europe, zero represents the temperature of melting ice, a temperature 32° F higher than that obtained by the former method which was first introduced by Fahrenheit. Consequently, when a Fahrenheit scale thermometer is put into melting ice, its scale will read at 32°.

Both in England and on the Continent, the other fixed point is obtained by noting the temperature reached by water boiling in a metal vessel at the ordinary atmospheric pressure of 29.921 inches or 760 m.m. mercury.

Having noted carefully the manner in which these fixed points are obtained, we may pass on to the three scales in common use.

On the Continent the space between zero and boiling point is divided into 100 parts and this division is known as the Centigrade or Celsius scale. Another scale introduced by Réaumur exists in which the space between the extremes is divided into 80 parts only.

In England and America, however, where the Fahrenheit scale is in general use, the space between zero and boiling point is divided into 212 parts. Owing to the different methods employed in obtaining zero, the temperature of melting ice on the Fahrenheit scale is 32° F.; therefore 100° C. or 80° R. equal 212°F. less 32, that is to say 180°F.; therefore 1° F $= \frac{5}{9}^\circ$ C. or $\frac{4}{9}^\circ$ R.

To convert Fahrenheit degrees into C. or R., one must first deduct 32 and then multiply by the relative value of the two degrees—

$$\text{F.} \times \text{C.} = (\text{F}-32)\ \tfrac{5}{9} = \text{C.}$$
$$\text{F.} \times \text{R.} = (\text{F}-32)\ \tfrac{4}{9} = \text{R.}$$

Conversely, C. and R. degrees may be altered into Fahrenheit by adding 32 after multiplying by the ratio value.

$$\text{C.} \times \text{F.} = \tfrac{9}{5}\text{C.} + 32.$$
$$\text{R.} \times \text{F.} = \tfrac{9}{4}\text{R.} + 32.$$

To convert Centigrade into Réaumur multiply by $\frac{4}{5}$.
or to convert Réaumur into Centigrade multiply by $\frac{5}{4}$.
The Fahrenheit and Centigrade scales agree at—40°.

The boiling point of a liquid is the temperature at which the pressure of its vapour equals that of the atmosphere upon it and is influenced by (1) the nature of the liquid, (2) the pressure on it; the lower the pressure the lower the boiling point; (3) the nature of the vessel in which it is contained; the boiling point is higher in a glass vessel than in a metal one; (4) air dissolved in the fluid lowers the boiling point and (5) substances in solution raise the boiling point.

There are many varieties of thermometers in use, including standard thermometers, ordinary, maximum and minimum, self-recording and radiation thermometers.

A Standard Thermometer is merely one made with very great care to secure accuracy. Unless intended for use in very cold climates, it is usually made to contain mercury.

Ordinary Thermometers should be occasionally checked against a Standard one. They usually contain mercury.

Maximum Thermometers.—There are several well known forms.

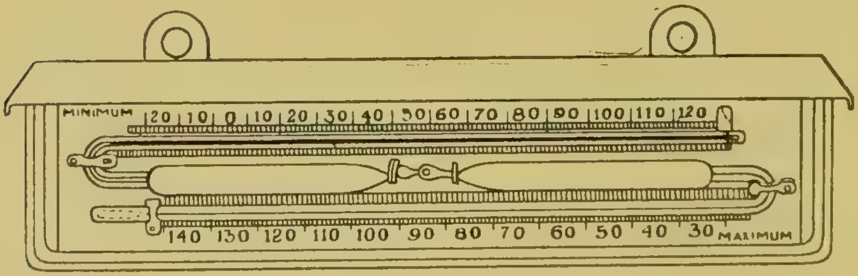
Philip's Maximum is a mercurial thermometer; it is so manufactured that a small bubble of air is introduced into the tube in such a manner as to separate a portion of the mercury from the remainder. To set the instrument, the bulb end is lowered and the instrument is gently tapped until the detached portion almost joins the rest of the column. The instrument is placed in the horizontal position with, if anything, a slight depression of the bulb end. On the temperature rising, the mercury expands and rises up the tube pushing the detached portion forward in front of it. On the temperature falling, the portion detached by a bubble of air is left behind.

In reading the instrument, the end of the detached portion furthest from the bulb records the highest temperature reached.

Negretti's is also mercurial and is suspended in the horizontal position also. In this the detachment of a portion of the mercury is brought about, not by a bubble of air, but by a slight contraction of the lumen of the tube, which does not interfere with the expanding mercury, but yet prevents the return thereof, as the molecular attraction of the metal is insufficient to enable it to pass the obstruction. To set the instrument, gently tap it when the bulb is lowered or gently swing it. The extremity of the detached portion farthest from the bulb shows the highest temperature reached.

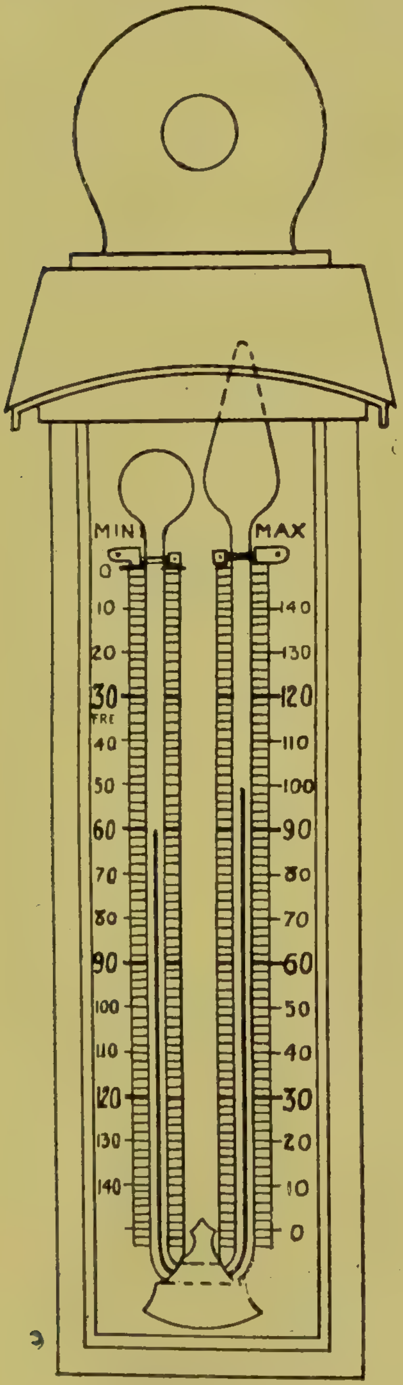
Minimum Thermometers.—There are two main patterns.

Rutherford's Thermometer.—The bulb and part of the stem are filled with alcohol in which a glass index is placed. When the temperature falls, the alcohol contracts and the capillary



RUTHERFORD'S THERMOMETER.

attraction of the liquid draws the index back with it towards the bulb. On the temperature rising, the alcohol flows past the index leaving the temperature, opposite the end of the glass index farthest from the bulb, as the lowest temperature recorded. The instrument should be set in a nearly horizontal position, with the bulb-end slightly lower.



SIX'S THERMOMETER.

To set it ready for use, unhook it from its supports and raise the bulb-end and let the index fall to the top of the column of spirit.

Casella's Minimum is a mercurial thermometer and contains no steel or other index. It consists of an ordinary thermometer tube, which at the bottom end communicates with a tube of much larger bore, at the end of which is a small chamber whose inlet is larger than the bore of the main tube or thermometer.

When the temperature falls, the mercury withdraws in the indicating tube only and if it rises then the mercury passes through the easier broad bore tube into the chamber and does not pass up the main or thermometer tube.

The instrument is hung horizontally.

To set it, raise or lower the bulb end so as to fill most of the indicating tube and empty the chamber.

Registering Thermometers :—The oldest is probably that made by James Six and bears his name. The tube of the instrument is long and U shaped. One limb of the U ends in a bulb and is known as the cold tube; the other ends in a small chamber which contains some air: this is known as the hot tube.

The bend of the U and a portion of each tube contain mercury. The bulb and both tubes above the mercury contain alcohol. In both tubes there is a steel index.

The instrument is hung in the vertical position.

To set it, use a magnet and gently draw down each index until it rests on the surface of the mercury.

If the temperature rises, the alcohol in the bulb expands and pushes the Hg. down in the cold leg and up in the hot leg. If the temperature falls, the alcohol contracts and the air in the chamber at the top of the hot leg forces the Hg. down in it and up in the cold leg.

In each case the reading is taken from the level of the lower end of the index. The temperature scale reads downwards in the cold leg and upwards in the hot leg. Occasionally alcohol oozes past the mercury and runs from the cold to the hot leg; this throws the reading entirely wrong and the instrument should be sent to the maker to remedy it.

Self-recording Thermometers.

Richards Frere's.—In this, the bulb is a long curved flattened tube filled with liquid, or two strips of metals of different co-efficients of expansion soldered together which tend to straighten on a rise of temperature and, being connected with a long lever, record rises and falls of temperature on a tracing paper worked by clock-work. It needs frequent comparison with a standard thermometer.

Many thermometers now record variations automatically on sensitized paper.

Causes of Interchange and Variation of Temperature.

An interchange of temperature between bodies heated to different degrees takes place owing to conduction, convection and radiation.

By *conduction* is understood the communication of heat from particle to particle in the same body. Its progress is gradual and not instantaneous as is the case in radiation. The best conductors are the metals. Solids are better than liquids and the latter better than gases, but both liquids and gases as well as glass and wood are bad conductors.

Convection is the mode by which heat is transmitted through a fluid and the movements of the air to which we apply the term wind; the currents of the sea are also due to convection, which depends on the alteration in the density of the particles which causes them to rise to the surface when heated and *vice versâ* when cooled.

Land and sea breezes are due to convection: the land during the day becomes warmer than the ocean and by radiation it imparts its heat to the air above it and this heated air rises allowing colder air from the sea to take its place. During the night, the land and sea both grow colder and the former more rapidly than the latter owing to the high specific heat of water and consequently, the relative temperatures of the two being now reversed, a breeze blows from the land towards the sea.

Radiation. Heat can be transmitted from one body to another without altering the temperature of the intervening medium. Heat thus propagated is said to be radiated. The property of radiating heat is not confined to luminous bodies such as a fire, or a red hot ball, but bodies of all temperatures radiate heat. Certain laws apply to radiation of heat.

(*a*) Radiations take place in all directions from a body.

(*b*) In a homogeneous medium, radiation takes place in a right line, but in passing obliquely from one medium into another, as from air into glass, rays are refracted just as rays of light are.

(*c*) Radiant heat is propagated in vacuo as well as in air.

The intensity of radiant heat is (1) proportionate to the temperature of the source; (2) inversely as the square of the distance from the source; (3) less the greater the obliquity of the rays with respect to the radiating surface.

Solar Radiation.—The most intense of all sources of heat is the sun; the heat rays from which falling on the land are arrested at the surface, the amount of absorption depending on the conducting power of the soil; but on water the rays penetrate some distance below the surface.

An idea of the intensity of the sun's rays is obtained by placing a maximum thermometer direct in the sun's rays. In order to prevent loss of heat by reflection, the bulb and one inch of the stem are blackened with lampblack. The thermometer is placed in vacuo in a glass case.

It should be placed about 4 feet from the ground away from walls, trees and houses.

At the same time a maximum thermometer is similarly exposed away from trees, etc., but in the shade and not in vacuo. The excess of the temperature of the black bulb over that of the surrounding air, as measured by the ordinary maximum thermometer, is an approximate measure of the actual sun's rays.

Terrestrial Radiation.—The heat received by the earth is again radiated from it and as a result of this alternate absorption and radiation the mean temperature of the earth seldom varies.

As soon as the sun sets, the earth begins to radiate heat into space and thus to become chilled. This chilling process however is modified by (*a*) the presence of clouds which radiate back the heat to the earth, (*b*) the deposition of dew by which a large amount of latent heat is set free, (*c*) the presence of a wind which lessens the rapidity at which the earth cools, owing to the fact that the earth comes in contact with the air of the upper as well as the lower strata of the atmosphere due to the movements caused by the wind, (*d*) the surface of the earth which receives a certain amount of heat from the air in contact with it and also by (*e*) radiation downwards from the air above it.

Similarly, the radiation of heat from water is modified, because (1) water has greater specific heat and, therefore, cools more slowly than land, (2) the cooler particles of water sink and are replaced by warmer ones and this process is very slow; thus the temperature of the surface of the water can only be lowered by the temperature of the whole mass falling, which will require a longer or shorter time depending on the depth of water.

The loss of heat due to terrestrial radiation is measured by placing a minimum thermometer on short supports about 4 inches high from the ground, preferably on a grass plot. Should snow lie on the ground it can be placed directly on the snow.

At the same time a minimum thermometer is exposed in the usual way and the difference between it and the one laid near the ground is recorded as the amount of terrestrial radiation.

Due to the distance of the sun from the horizon, the temperature of a place varies from hour to hour. The mean temperature of the day is determined in most Observatories by recording the height of the thermometer at every moment of the day by photography.

Failing this it can be estimated--

(1) by taking readings at two hours of the same name, *e.g.*, 8 A.M. and 8 P.M. or 9 A.M. and 9 P.M.: the mean of these readings more or less approximates the true mean;

(2) from three daily observations at say: 6 A.M., 2 P.M. and 9 P.M.

The daily minimum temperature is about 1 hour before sunrise and the maximum about 2 hours after noon.

The mean temperature of a place is determined by adding the mean temperature for several months and then dividing by the number of the months embraced by the observations.

In exposing a thermometer it is essential to see that a constant circulation of air is kept up round the thermometer bulb and that this air has not just previously passed over a very hot or a very cold surface; the bulb must also be protected from the direct rays of the sun and from radiation from objects in the immediate vicinity. To meet these requirements a Stevenson's screen is used largely. It consists of a box on legs 4 feet high. The sides are louvred and the roof ridged and it is open below. It should be placed at least 20 feet away from any building or wall.

Maximum and minimum thermometers are usually read once a day, *viz.*, at 9 A.M.

The Barometer or Measure of Weight.

The atmosphere at sea-level exerts a pressure of about 14·64 lbs. per square inch.

It can support a column of mercury 29·92 inches high. Taking the density of water as 1 and mercury as 13·59, the column of water sustained would be 33·9 feet.

Similarly, the atmospheric pressure can sustain a column of alcohol 42·4 feet.

For general use mercury is chosen, as it is portable and the tube containing it is not so unwieldy as in the case of water; moreover, in the water-barometer the space above the water is not a true vacuum, as it very nearly is in the mercurial barometer.

In its simplest form a barometer consists of a glass tube about 33·36 inches long, closed at one end and open at the other. The tube is one inch in circumference. It is completely filled with mercury and then inverted with its open end downwards in a vessel containing mercury, great care being taken to see that no air enters the tube. The tube being held in a vertical position, the column of mercury in it sinks and, after oscillating for some time finally comes to rest at a point about 30 inches above the mercury in the trough. The space thus left between the mercury and the top of the tube is known as a Torricellian Vacuum.

Certain precautions must be adopted in filling a barometer, amongst which are—

(*a*) The mercury used must be pure, (*b*) the tube must be perfectly dry; otherwise any moisture present rises as vapour to the top of the tube and forms an atmosphere depressing the mercury; (*c*) the mercury must be boiled to expel air and moisture, and (*d*) the tube must be of uniform calibre.

The Siphon Barometer consists of a bent tube of uniform calibre; one of the branches is much longer than the other. The longer branch which is closed at the top is filled with mercury, while the shorter branch which is open serves as a cistern. The difference between the two levels is the height of the barometer.

The Cistern Barometer.—the tube, as previously described, is filled with mercury and inverted into a vessel or cistern also containing mercury, and the whole is fixed to a scale.

There are certain sources of error in the ordinary cistern barometer—

(*a*) Capillarity, (*b*) Capacity, (*c*) Temperature, (*d*) Height and (*e*) Index.

Capillarity.—The effect is to depress the column of mercury, the amount of depression varying with the internal diameter of the tube. The smaller the diameter the greater the error.

The correction is always positive.

Capacity.—This error is the result of the rising and falling of the mercury in the tube and the consequent ever varying level of mercury in the cistern.

It is evident that given a tube of mercury standing in a cistern of the same metal, a fall of the column must produce a rise in the level of the mercury in the cistern.

If, therefore, the scale of the instrument be laid off from a zero at any fixed point in the cistern, the readings will be wrong at every point but one. The movements of the column will always be too small in the ratio which the area of the cistern bears to the area of the tube.

Various devices have been proposed to overcome this.

Capacity Correction.—The ratio between the area of the tube and the cistern is noted and recorded on the scale, *e.g.*, Capacity $\frac{1}{40}$. On the scale there is always a certain height which is correctly marked; this may be called the neutral point. Now, if the mercury falls below this, the height read will be too great, because the level of the mercury in the cistern is above zero; and *vice versâ.* To apply this correction, multiply the difference between the observed height and the neutral point by the capacity correction and add it to the reading when the column is higher and subtract when it is lower than the neutral point or height.

Kew Pattern.—No attention is paid to the mercury in the cistern, but the graduations on the scale are only in nominal inches, being shorter than true inches from above downwards in proportion to the relative size of the tube and cistern.

Fortin Pattern of Barometer differs from the ordinary barometer in the shape of the cistern which consists of a glass cylinder through which the mercury can be seen. This is closed at the top by a box-wood disc fitted on the under-surface of the brass cover. Through this passes the barometer tube which is drawn out at the end and dips into the mercury in the cistern. The bottom of the cistern is made of leather and can be raised or lowered at will by means of a screw. Attached to the top of the cistern is a small piece of ivory tapering to a point (called the fiducial point). Before taking a reading of the barometer, the mercury in the cistern should be raised or lowered until it just touches the fiducial point. The error seen in the ordinary barometer is removed by laying off the scale from the extremity of this fiducial point. The inches marked on the scale are true ones.

A barometer should be placed indoors in a good light but not in the sun, and it should be suspended vertically.

To read a Barometer.—For accuracy it is necessary to use a vernier or sliding scale running parallel to the principal scale. A vernier in general use is one in which 25 divisions of the vernier are equal to 24 divisions of the barometer scale. And since each division of the barometer scale=0.05 inch, a vernier division will thus be less than a main scale division by

$$\frac{1}{20 \times 25} = 0.002 \text{ inch.}$$

The scale for reading the height of the column of mercury is divided into inches, tenths and half-tenths ($\frac{1}{20}$) of inches; and, to obtain more accurate readings than the scale alone allows, a sliding scale or vernier is attached, which serves to indicate the amount of space occupied by the Hg. between the half-tenth lines. The vernier scale is divided into 25 equal parts, which correspond to 24 half-tenth divisions on the barometer scale, consequently each division on the vernier is $\frac{1}{25}$ less than a half-tenth division on the barometer scale, and is therefore $\frac{1}{25}$ of $\frac{1}{20}$ inch=·002 inch.

To use the vernier, adjust it so that its lower edge just corresponds with the top of the meniscus of the mercury. If the lower edge exactly corresponds with one of the smaller divisions of the main scale, then this division represents the exact reading of the barometer.

But if the lower edge of the vernier does not so correspond exactly, then one must follow up the scale until the point is reached where a vernier division and a principal scale division do exactly coincide.

Now count off the number of vernier divisions between this point and the lower edge and add the result to the reading shewn on the principal scale and so obtain the reading corresponding with the top of the mercury.

Having read the barometer with the aid of a vernier, there are certain corrections which it is necessary to apply.

(1) *Index Error.*—This lies in the instrument itself; it is generally the same at all parts of the barometric scale and is very small. It may be positive or negative, the fact being usually stated on a certificate.

(2) *Capillarity.*—The correction is always positive. These two errors are often grouped together and an inclusive figure is given in a certificate with the barometer.

In the Siphon Barometer errors for capillarity and capacity do not exist and are, therefore, not allowed for.

(3) *Correction for Temperature.*—Two corrections have to be made here, one for the expansion of the mercury, and the other for that of the brass.

For purposes of accurate comparison all readings should be reduced to 32° F. or 0°C.

Mercury expands on heating and contracts on cooling. The co-efficient of expansion is 0·0001 for every degree F. rise of temperature, *i.e.*, a given volume of Hg. at 32° F. increases 0·0001 of this volume for every rise of 1° F. above 32° F.

To correct, use formula.—

$$\text{Height} = \frac{\text{Indicated height.}}{1 \times \cdot 0001\ (t-32)}$$

e.g. Barometer reads 29·452 inches ; Thermometer 62° F
Find height at 32° F.

$$\text{Height} = \frac{29.452}{1 + \cdot 0001 \times 30} = \frac{29.452}{1.003}$$

$$= 29.363 \text{ inches.}$$

The index is made of brass, and this also expands on heating and contracts on cooling.

The necessary corrections can be obtained from a special table.

(4) *Correction for Height.*—For purposes of comparison all barometric readings are reduced to mean sea-level.

As a rule mercury falls about 1 in. for every 900 feet ascended—*i.e.*, about $\frac{1}{900}$ or 0·001 inch for every foot ascended, and this amount multiplied by the number of feet ascended must be added to the observed height, if the place be above the standard level. Temperature falls about 1° for every 300 feet ascended.

Aneroid Barometer, i.e., a barometer without a liquid. It consists of a metal box from the interior of which the air is exhausted. Any increase of atmospheric pressure compresses the box and the motion is by suitable levers made to move the hand on the face of the Aneroid. They can never be relied upon for fixed stations, as they may work extremely well for a time and then go hopelessly wrong. Checked against a standard barometer frequently, they are valuable in measuring altitudes. They should always be read in one position and not at one time hanging and at another lying flat.

To ascertain the altitude by a barometer.—Read the Aneroid to the nearest $\frac{1}{100}$ of an inch. Subtract the upper station reading from the lower.

Neglect the decimal point and multiply by 9. Result is in feet.

Note.—If temperature is above 70 or upper barometric reading is below 26, then multiply by 10.

Another method :—

(1) Take the mean of the barometric readings of the upper and lower stations.

(2) Take the mean of the temperatures of the upper and lower stations.

(3) From a table find the height of a column of air which will at this mean pressure and temperature support 1 m.m. of mercury.

(4) Multiply this by the difference between the two barometric readings.

(5) Result is in metres.

Recording Barometers.

Many varieties of recording barometers are made. One by Richard Fréres consists of a series of aneroid bones, the movements of which are magnified by a long lever, on the end of which is a marker which records on a cylinder, rotated by clockwork, the varying motions of the barometer at any particular time of the day (24 hours).

HUMIDITY.

The term implies the amount of vapour present in the air and also the ratio of this to the amount which would saturate the air at the actual temperature.

The amount of vapour in the air is not a measure of its humidity, for the air is for the most part drier in summer than in winter, although the amount of vapour present is much greater.

At all ordinary temperatures water gives off vapour and it evaporates into dry air as into a vacuum, but the volume of the resulting moist air is greater than that of the original dry air.

The higher the temperature of the air, the greater the pressure of the water vapour, *i.e.*, the amount of moisture which the air can hold is constantly varying with its temperature. Thus at 32° F. a cubic foot of air can take up only 2·10 grains of aqueous vapour, while at 100° F. it can take up as much as 19·84 grains. When the air is so full of moisture that it can hold no more it is said to be saturated.

The volume of moist air is greater than that of dry air, *e.g.*, a cubic foot of dry air at 60° F. weighs 536·3 grs. and can take up 5·77 grs. of water. The product, however, is not one cubic foot of moist air weighing 542·1 gr. but 1·0176 cubic feet, and a cubic foot of the same moist air weighs only 532·7 grains.

As a rule, the water present is only about 70 or 75 % of the amount required to saturate it, but if the air is cooled, the same amount of aqueous vapour may suffice to saturate it, *e.g.*, 100 cubic feet of air, three parts saturated at a temperature of 70° F. would hold 600 grs. of aqueous vapour ; if for some cause or other the temperature of the air be reduced to 61° F., then that volume of air would become quite saturated, because at that temperature it could only hold 600 grs.; and if the temperature be still further reduced, say to 56° F., it could only hold 500 grs. and the difference therefore (*viz.*, 100 grs.) would be deposited as mist, dew or rain.

In perfectly pure air a pressure of vapour may be maintained greater than that corresponding to the temperature of saturation.

It is on the presence of solid particles of dust in the air that the formation of mists and fogs depends : the precise degree of mist or fog depending on the amount of dust present and on the size and constitution of the particles. Such atmospheric dust probably consists of fine salt particles from the sea, meteoric dust, products of combustion, and animal, vegetable and mineral matter.

When the number of dust particles is large or their size is considerable, and the quantity of vapour condensed is small, we get the phenomenon of a town fog or so-called dry fog.

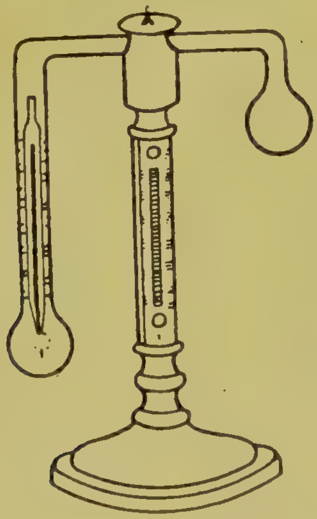
Sea fogs probably occur in air, which is comparatively dry, because the nucleus in their case consists largely of salt grains derived from spray or surf which have a great affinity for moisture.

The formation of dew is analogous ; it is formed by the condensation of aqueous vapour on the ground or on blades of grass, instead of round nuclei of dust in the air as is the case in fogs. The earth cools at night by radiation and this reduces the temperature of the air in its vicinity and at length a point is reached when the air, at that particular temperature, is unable to support the amount of water vapour contained in it and consequently the surplus is deposited as dew. The particular temperature at which this deposition occurs is known as dew-point, and it is from the determination of this that the amount of moisture present in the air is calculated.

The instruments used are known as Hygrometers and there are several patterns. Some give the information required in a direct manner, *e.g.*, Daniell's, Regnault's, and Dine's, others require certain calculations in order to arrive at a result, *e.g.*, the dry and wet bulb thermometers.

Direct Hygrometers.

Daniell's Hygrometer consists of a bent glass tube, supported on a stand. At the end of the rectangular bends is a bulb. One bulb is of black glass and contains ether, and a thermo-



DANIELL'S HYGROMETER.

meter the stem of which is visible in the tube above. The other bulb and the remainder of the glass tube contain the vapour of ether and the bulb itself is covered with muslin.

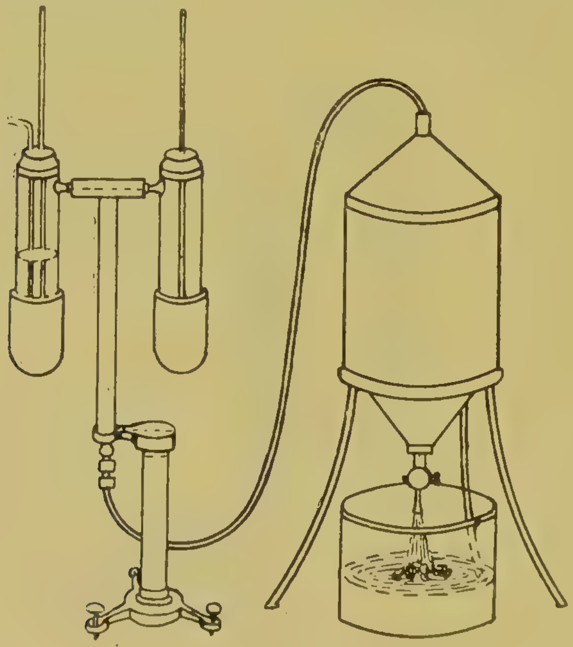
To use the instrument.—The muslin is wetted with ether and by its evaporation the temperature of the bulb is lowered; this causes a condensation of the ether vapour in the tube and bulb, and as a result an increase of evaporation from the ether in the black bulb with, in consequence, a lowering of the temperature in that bulb. As soon as the temperature of the black bulb sinks to the dew-point, then the black surface is dulled by the deposit of atmospheric vapour and this temperature is at once read off by means of the contained thermometer.

A thermometer is generally attached to the stand and gives the temperature of the adjacent air.

On account of the low boiling point of ether, this hygrometer cannot be used in very hot climates. (The boiling point of ether is 36° C. or 97° F.)

The temperature at the moment of the deposit of moisture on the ether bulb is really a little lower than the dew-point; if, however, the instrument be left alone and the temperature noted at the moment of the disappearance of the dew, the mean of the two readings will give the correct dew-point.

Regnault's Hygrometer is a modification of Daniell's.



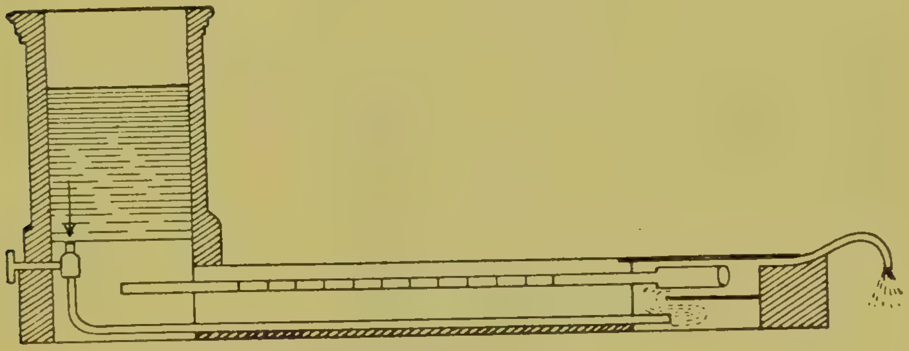
REGNAULT'S HYGROMETER.

It consists of two thin glass tubes A and B, corked at one end and fitted into two thin silver thimbles suspended on a stand; a thermometer is placed in each, the stems of which pass through the corks.

The tube A contains some ether and a glass tube opening below the ether passes through the cork and is open to the air. It is connected with an aspirator.

To use the instrument.—The cock of the aspirator is turned on, air is drawn through A and the temperature is noted the moment the silver thimble becomes tarnished with moisture: this represents the dew-point.

Dine's Hygrometer is a very simple form. It consists of a wooden stand in which is a vessel containing ice-cold water; from this proceeds a pipe leading to a space containing a thermometer. The roof of this space is covered in by blackened glass.

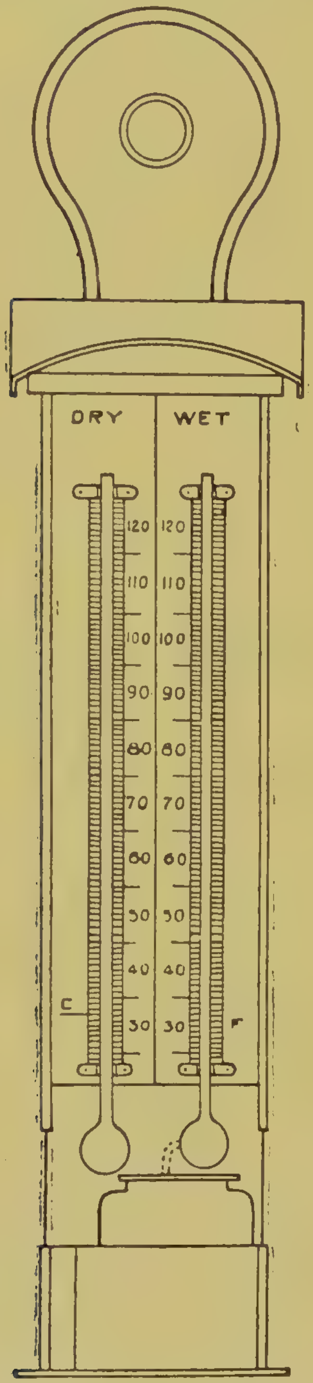


DINE'S HYGROMETER.

Cold water passes through the space beneath the glass plate, until the glass becomes dull from moisture deposited on it. The moment this occurs, the temperature of the contained thermometer should be read off.

Saussure's depends for its action on the fact that a human hair elongates when moistened and contracts on being dried. The hair is deprived of all grease by washing it in ether or in liquor potassae, and it is then fastened at one end and to the other end is attached a small weight to stretch the hair. It passes round a movable axis, which carries a lever pointing to a graduated arc. As the hair expands or contracts, it rotates the axis and indicating lever. The arc is graduated first for perfectly dry air = O, and then for air saturated with moisture = 100 and the intervening space is graduated accordingly.

The Wet and Dry Bulb Thermometer consists of two thermometers set in a frame side by side. The bulb of one of these is covered with muslin which, by the aid of a piece



THE WET AND DRY BULB HYGROMETER.

of wick and a small receptacle for water placed under the thermometer, is kept constantly wet.

If the air is saturated with moisture, no evaporation takes place from the wet bulb and its reading will be the same as that of the dry bulb thermometer which gives the reading of the ordinary temperature of the air. If, however, the air be not saturated, evaporation takes place from the wet bulb, thereby lowering its temperature. The drier the air the faster the evaporation taking place, and consequently the greater the cooling and the fall in the thermometer. In frosty weather the muslin may be hard, in which case one must merely brush it over with water.

From the wet and dry bulb readings the dew-point can be calculated, and from the dew-point the weight of water present in the air.

The dew-point can be very roughly ascertained (*a*) by taking it to be as much below the wet bulb reading as that is itself below the dry bulb reading; or (*b*) by the use of Glaisher's Factors, thus: Take the difference between the dry and wet bulbs: multiply that by the factor opposite the dry bulb reading; deduct the product from the dry bulb reading and the result is the dew-point.

Precautions in using the wet and dry bulb thermometers.

(1) Both thermometers must be exactly alike.
(2) Free circulation of air must be maintained round the wet bulb.
(3) The vessel containing the water should be small and placed some inches from both bulbs.
(4) The muslin must be kept thoroughly moist, but not allowing a collection of water at the bottom of the bulb.

Example of the working of Glaisher's Factors.

Dry bulb reading	40
Wet bulb ,, ...	36

Factor opposite Dry bulb reading of 40 = 2.29.

Then,

$$40 - 36 = 4$$
$$4 \times 2.29 = 9.16^\circ$$
$$40 - 9.16 = 30.84^\circ$$

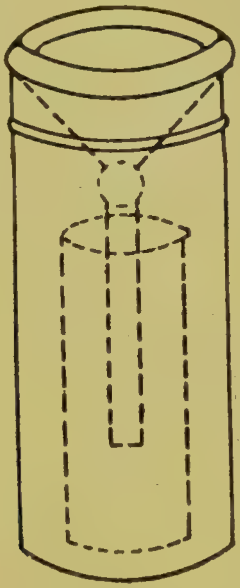
Glaisher's Factors.

Reading of Dry-bulb Therm.	Factor.	Reading of Dry-bulb Therm.	Factor.	Reading of Dry-bulb Therm.	Factor.	Reading of Dry-bulb Therm.	Factor.
°		°		°		°	
10	8.78	33	3.01	56	1.94	79	1.69
11	8.78	34	2.77	57	1.92	80	1.68
12	8.78	35	2.60	58	1.90	81	1.68
13	8.77	36	2.50	59	1.89	82	1.67
14	8.76	37	2.42	60	1.88	83	1.67
15	8.75	38	2.36	61	1.87	84	1.66
16	8.70	39	2.32	62	1.86	85	1.65
17	8.62	40	2.29	63	1.85	86	1.65
18	8.50	41	2.26	64	1.83	87	1.64
19	8.34	42	2.23	65	1.82	88	1.64
20	8.14	43	2.20	66	1.81	89	1.63
21	7.88	44	2.18	67	1.80	90	1.63
22	7.60	45	2.16	68	1.79	91	1.62
23	7.28	46	2.14	69	1.78	92	1.62
24	6.92	47	2.12	70	1.77	93	1.61
25	6.53	48	2.10	71	1.76	94	1.60
26	6.08	49	2.08	72	1.75	95	1.60
27	5.61	50	2.06	73	1.74	96	1.59
28	5.12	51	2.04	74	1.73	97	1.59
29	4.63	52	2.02	75	1.72	98	1.58
30	4.15	53	2.00	76	1.71	99	1.58
31	3.60	54	1.98	77	1.70	100	1.57
32	3.32	55	1.96	78	1.69		

Rainfall.

As the clouds consist of particles of water, they are constantly raining; but between the clouds and the earth there is usually a non-saturated belt of air or region, where these particles of water, when small, are evaporated before they reach the earth. The physical cause of rain is the sudden chilling of comparatively warm moist air, either by its ascent into the upper and colder regions of the atmosphere or by its contact with cold mountain slopes. It has been estimated that one gallon of rainfall by its condensation from a vapour into liquid form gives out latent heat enough to melt 75 lbs. of ice. The condensation of one grain of aqueous vapour gives out enough heat to raise 536 grains of water 1° C.

To collect and measure the rain, rain-gauges are used. There are several forms of gauges. The simplest consists of a copper funnel leading to a bottle or receiver in which the rain is collected and from which it is drawn and measured. The funnel has a sharp circular rim and is generally either 5 or 8 inches in diameter; the rim should be truly horizontal, else the gauge will catch too much or too little according to the direction and force of the wind. The tube leading from the funnel to the bottle should be long and narrow so as to lessen loss by evaporation.



RAIN-GAUGE.

The best position to place the gauge is on the ground about one foot above the level of the earth, in an exposed position free from trees, houses, etc. No object ought to subtend a greater angle with the horizon than 20° in any direction from the gauge. Others, however, contend that the best position is to bury it in the earth making its top just even with the surface of the ground.

More rain is collected on or near ground level than on the top of a building or on a stand at a height above the ground. This has been ascribed to the fact that the rain drops, which are generally colder than the layers of the air which they traverse, condense the aqueous vapour in these layers and therefore constantly increase in volume; hence more rain falls on the surface of the ground than at a certain height. But it has been objected that the excess of the quantity of rain which falls over that at a certain height is six or seven times that which could arise from condensation, even during the whole course of the raindrops from the clouds to the earth. The difference must therefore be ascribed to purely local causes; and it is now assumed that it arises from eddies produced in the air about the rain-gauge which are more perceptible the higher it is from the ground; and as these eddies disperse the drops which would otherwise fall into the instrument, they diminish the quantity which it receives. In any case it is clear that, if raindrops traverse moist air, they will, from their lower temperature, condense aqueous vapour and increase in volume, and *vice versâ.*

Snow and hail collected in the rain-gauge can be melted for measurement by adding a known volume of warm water and deducting that quantity in subsequent calculations.

To calculate the quantity of rain intercepted by the rain-gauge, the rain collected in the receiver is measured in a graduated glass vessel, the divisions of which correspond to $\frac{1}{2}$ inches and $\frac{1}{10}$th inches, marked in proportion to the area of the gauge, which should always be either 5 or 8 inches in diameter.

For example.—The gauge is 8 inches in diameter.

The area of the opening, therefore, is $= \pi\rho^2$ or $\delta^2 \times 0{\cdot}7854$;

$$\begin{aligned} &= 16 \times 3{\cdot}1416; \\ &= 50{\cdot}2656 \text{ sq. inches}; \\ &= 29{\cdot}08 \text{ fluid oz.} \end{aligned}$$

Therefore, place 29.08 fluid ounces of water into the glass measure and mark off the level of the surface of the water. This mark represents one inch of rain in that particular 8-inch gauge. The height marked off is then subdivided into $\frac{1}{10}$th of an inch, etc.

The measuring glass must be held quite level when taking readings. Readings are best taken at 9 a.m. The gauge should be overhauled occasionally to see if there is any sign of leakage or damage.

The amount of rain which falls varies very much, of course, with the place. In England and Wales the average rainfall is 33·76 inches; in Scotland 46·56; in Ireland 38·54.

Other things being equal, most rain falls in hot climates for there the vaporisation is most abundant. The rainfall decreases, in fact, from the equator to the poles. So also the quantity varies with the season. In Paris, in winter, it is 4·2 inches, in summer 6·3.

The heaviest annual rainfall of any place is on the Khasi Hills in Bengal, where it is 600 inches.

The rainfall diminishes with the height of a station above the sea-level at the rate of 3 or 4 % for each 100 feet above the sea-level.

An inch of rain on a square yard of surface = 4·67 gallons or 22·622 gallons per acre or 10 tons.

APPENDIX.

USEFUL MEMORANDA (Sanitary Record Diary).

AIR.

The average composition of atmospheric air may be taken to be as follows :—

	Vols. per 1000.
Nitrogen	771·2694
Oxygen	206·5940
Aqueous vapour	14·0000
Argon	7·7906
Carbon dioxide	0·3300
Ammonia	0·0080
Ozone	0·0015
Nitric acid	0·0005

Air mixed with other gases, or holding in suspension organic or inorganic substances, is considered impure.

The gaseous impurities are chiefly : –

Carbon dioxide (in excess),
Carbonic oxide,
Carburetted hydrogen, and
Sulphuretted hydrogen.

The suspended impurities are chiefly—

Seeds of plants,
Spores of fungi,
Bacteria, and
Dust (organic and inorganic).

The quantity of carbon dioxide (carbonic acid) present is a convenient test of the purity of air as regards the ventilation of rooms.

Air should be considered unfit for respiration when it contains more than 0·06 per cent.

The chief sources of carbon dioxide in the air of rooms are respiration and combustion.

An adult man gives off from 0·5 to 0·7 cubic foot of carbon dioxide in one hour, whilst he inhales from 16 to 18 cubic feet of air.

An ordinary gas burner consumes as much air as three men, and gives off about 1½ cubic feet of carbon dioxide, 4½ cubic feet of watery vapour, and 1⅓ grains of sulphuric acid per hour.

An oil lamp requires as much air as one man and gives off about ½ cubic foot of carbon dioxide per hour.

A candle requires half as much air as one man, and gives off 0·3 cubic foot of carbon dioxide per hour.

The quantity of moisture in wholesome air should not be less than 40 per cent. of saturation.

Expired air contains about 5 per cent. less oxygen and a little more than 4 per cent. more carbon dioxide than that which is inhaled.

From 25 to 40 ounces of water is passed off from the lungs and skin of a person in twenty-four hours.

No conclusion can be drawn from the *number* of bacteria present in air. The number is smallest after a fall of rain or snow, and very markedly increased during a dry wind.

The weight of a cubic foot of atmospheric air is ·08072 lb.

The cubical expansion of air for each degree of increase in temperature is, according to Regnault :—

Fahrenheit scale = ·0020361
Centigrade scale = ·003665

VENTILATION.

To ventilate rooms without causing draughts, air should be moved at the rate of not more than 2·5 ft. to ·5 ft. per second when the temperature is from 55 to 0 deg. Fah.

Dr. Parkes gives the following rule for determining the amount of fresh air necessary to dilute the impurities in the air of rooms sufficiently to render them harmless :—

Let e = The quantity of carbon dioxide exhaled by an adult per hour (= 0·6 cubic foot).

r = The quantity of carbon dioxide per cubic foot permissible in wholesome air (say 0·0006).

R = The quantity of carbon dioxide per cubic foot in the air naturally (=0·0004).

Q = The volume of air, in cubic feet, to be supplied per hour.

Then
$$Q = \frac{e}{r - R}.$$

This rule gives 3,000 cubic feet per hour when r= 0·0006.

Taking this quantity as being necessary for each person in the room per hour, a space of 1,000 cubic feet should be allowed for each individual, that the air may be changed at the rate of three times per hour. At this rate no inconvenience will be felt through draughts.

The minimum cubic space which should be allowed is :—

Living rooms (day rooms)	600	cub. ft. per head.
Dormitories	1,000	,, ,, ,,
Hospitals	1,300—1,500	,, ,, patient
Stables	1,600	,, ,, horse.

The usual cubic space allowed in public buildings is :—

Barracks	600	cub. ft. per head.
Military hospitals	1,200	,, ,, ,,
Civil hospitals	850—1,200	,, ,, ,,
Poor Law Board dormitories	300	,, ,, ,,

The ventilation of a room should take place in such a way that the exhalations of its occupants, &c., do not mix with the fresh air supply.

The inflow of air must be properly diffused and not permitted to pass direct from the inlets to the outlets in merely local currents and draughts.

Fresh air should be admitted at a low level and discharged at the ceiling, the natural ascent of air being rapid owing to its temperature.

With a temperature of 70 deg. Fah., the temperature of the air expelled from the lungs is from 85 deg. to 95 deg. Fah.

The heating of a room should always be distinct from its ventilation, air being rendered unfit for respiration by raising its temperature sufficiently to effectively heat the room. For heating purposes, radiant heat is the healthiest.

The fresh air supply should be proportionate to the extraction.

The combined areas of the inlets should be at least equal to, and preferably greater than, that of the outlet shafts.

Long inlet shafts are objectionable, as they harbour dirt and are difficult of access.

Numerous small fresh-air inlet shafts are preferable to one or two large ones, as they distribute the incoming air much better.

The inlets should be placed above the level of the people's heads.

The Commissioners on Improving the Sanitary Condition of Barracks and Hospitals, in their report (1861), recommend the following areas of inlets and outlets :—

Inlets.—1 square inch for each 60 cubic feet in the contents of the room.

Outlets.—For rooms on upper floor 1 square inch per 50 cubic feet contents. Room next below, 1 square inch per 55 cubic feet Room on lower floor, 1 square inch for each 60 cubic feet contents.

Short table of factors for calculating equivalents of weight, length and volume.

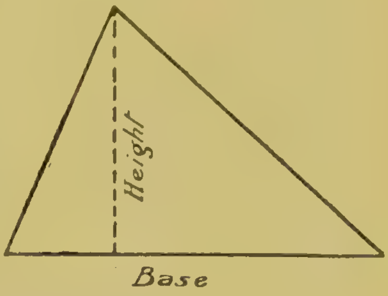
To convert ...	Grammes to grains	...	Multiply by 15·432
	Ounces to grammes	...	28·349
	Kilogrammes to pounds	...	2·204
	Metres to inches	...	39·37
	Kilometers to Miles	...	1·6
	Litres to gallons	...	0·22
	Litres to pints	...	1·76
	Pints to litres	...	0.5679
	Grains per gallon to parts per 100,000		10/7
	Cubic feet to gallons	...	6·23

CALCULATION OF AREAS.

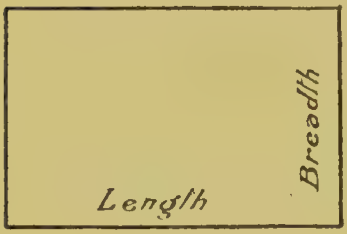
Triangle.

Area = Half the product of base and height.

This may be obtained by multiplying the base by the height and halving the product, or by multiplying the base by half the height or the height by half the base.



Quadrilateral or Four-sided Figures.

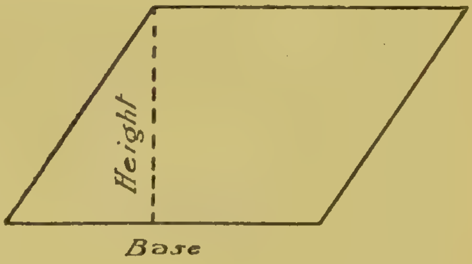


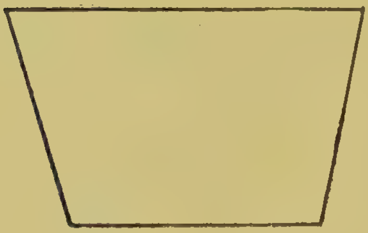
Rectangle and square (in both which all angles are square).

Area = The length multiplied by the breadth.

Rhombus or rhomboid (in which the opposite sides are parallel).

Area = The base multiplied by the perpendicular height.



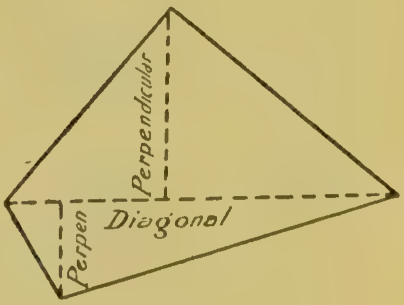


Trapezoid (in which two sides only are parallel).

Area = The mean length of the parallel sides multiplied by the perpendicular distance between them.

Trapezium (which has none of its sides parallel).

Area = Half the sum of the perpendiculars multiplied by the diagonal on which they fall.

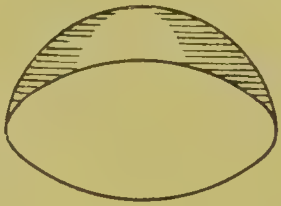


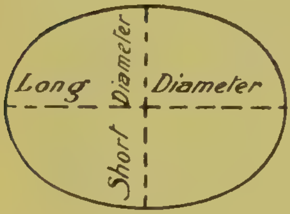
Globe or Sphere.

Volume = Cube of diameter multiplied by one-sixth of 3·1416 (*i.e.*, ·5236), *or* Area of circle having same diameter as sphere multiplied by two-thirds the diameter.

Segment of a Sphere.

Volume = Area of base multiplied by two-thirds of the height.





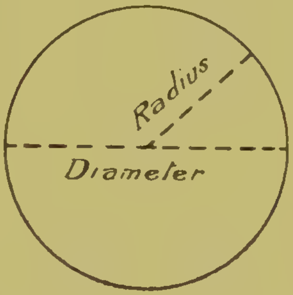
Ellipse.

Area = The long and short diameters multiplied together and the result multiplied by ·7854.

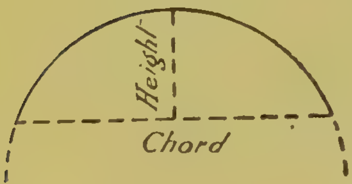
Circle.

Area = Square of diameter multiplied by ·7854, *or* square of radius multiplied by 3·1416.

NOTE.—The area of a circle is equal to that of a triangle whose base and altitude are equal to the circle's circumference and radius.



Segment of a Circle.

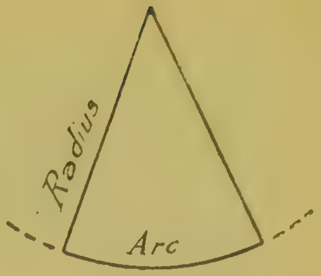


Area = The cube of the height divided by twice the length of the chord added to two-thirds of the product of chord and height, *or* the area of the sector which has the same arc, less the area of the triangle formed by the radii and the chord.

NOTE.—When the segment is greater than a semicircle, find the area of the circle and deduct the area of the smaller segment.

Sector of a Circle.

Area = Half the product of the arc multiplied by the radius, *or* length of arc multiplied by half the radius, *or* the number of degrees in the arc multiplied by the area of the circle and divided by 360.



Circumference of an Ellipse = Multiply half the sum of the two diameters by 3·1416.

Any figure bounded by right lines = Divide into triangles and take the sum of their areas.

Cubic Capacity of a solid triangle = Area of triangle × depth.

,, ,, ,, *Cone or pyramid* = Area of base × ⅓ height.

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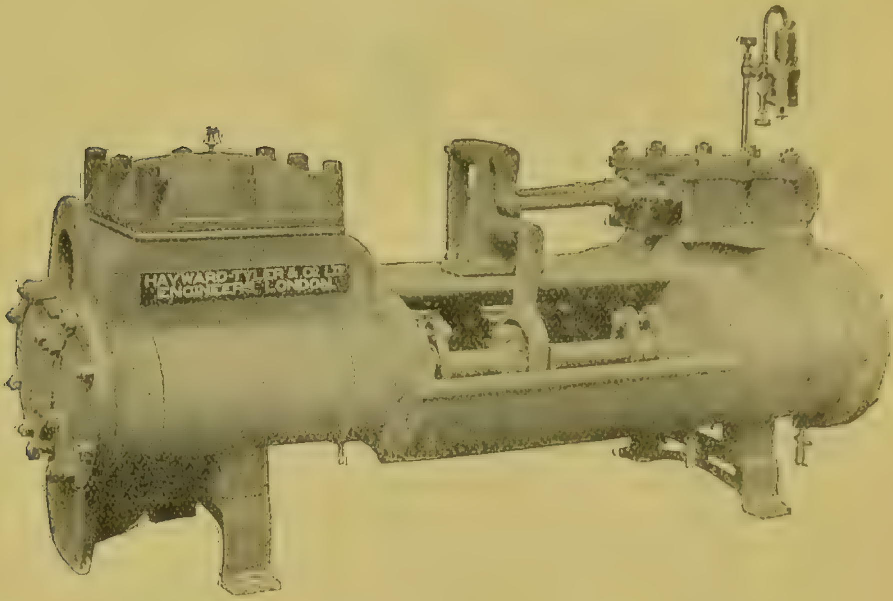

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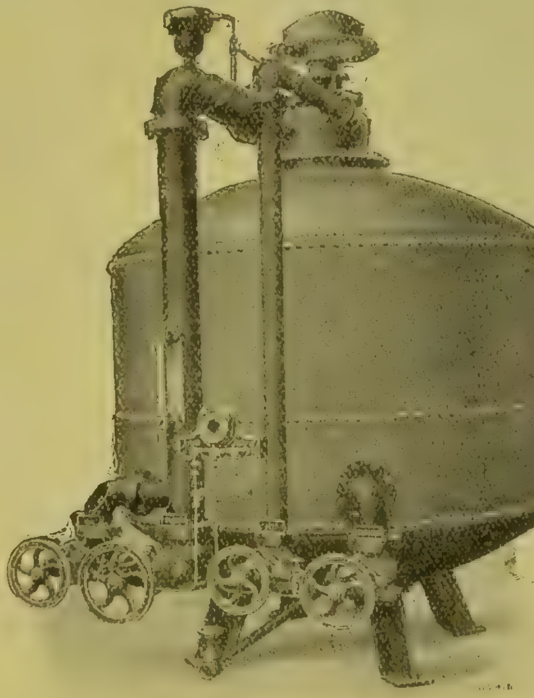

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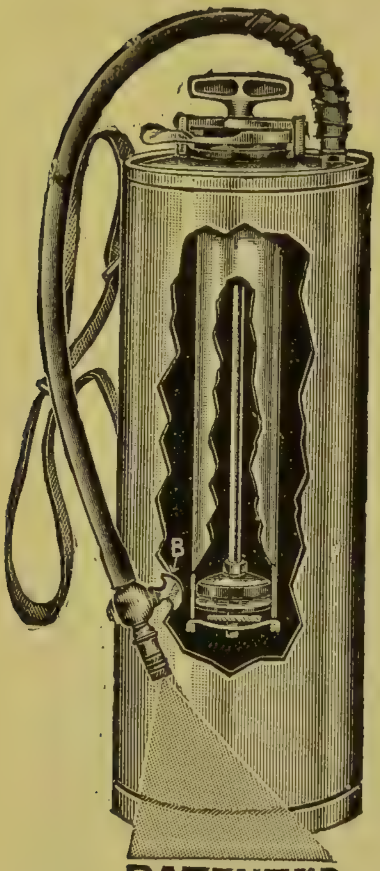

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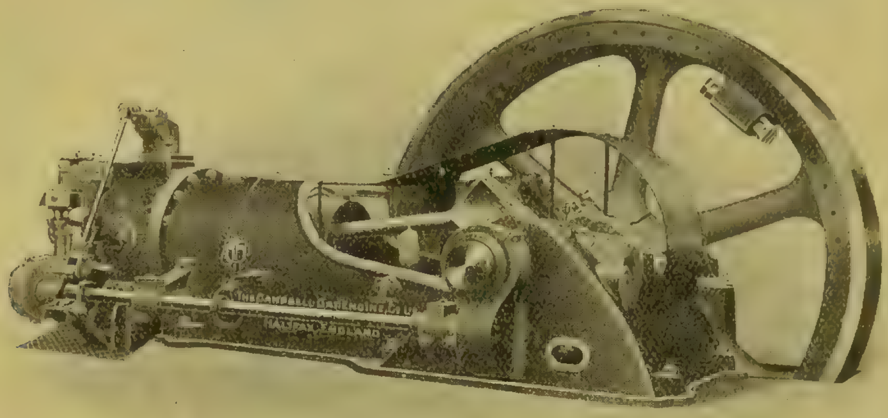

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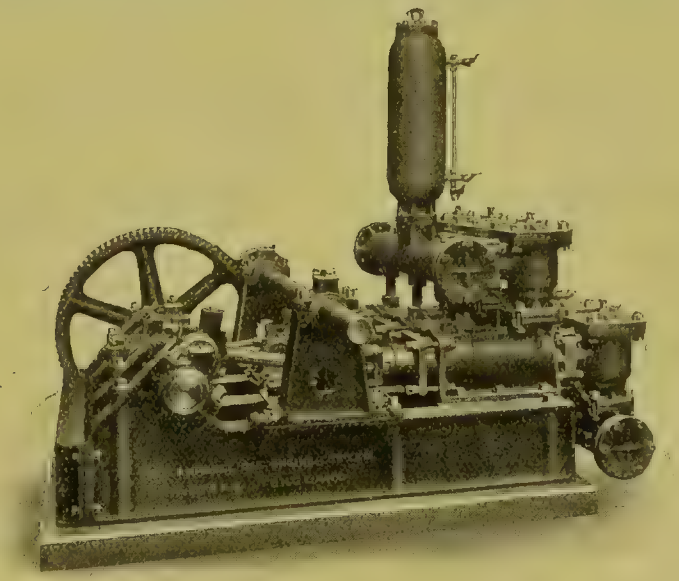

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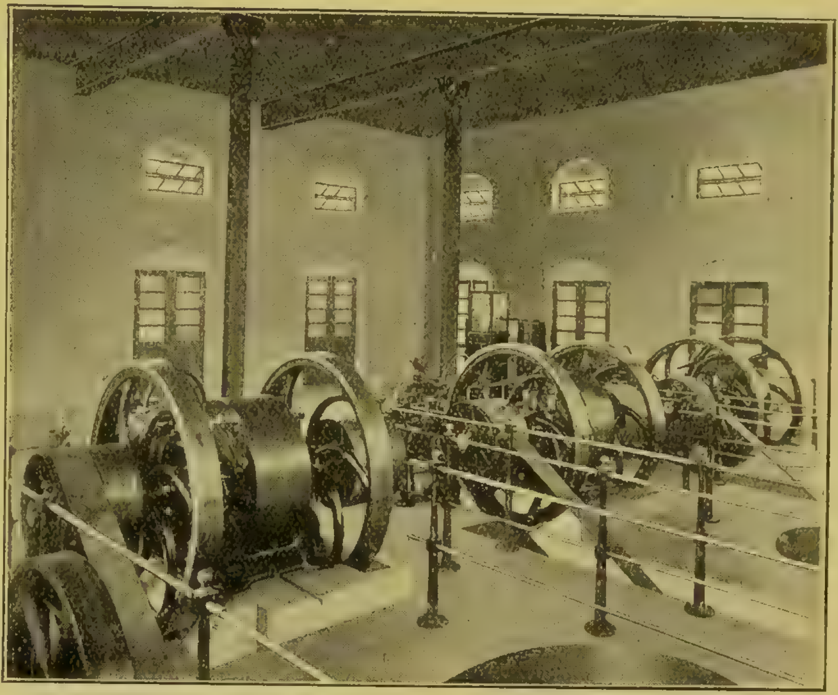

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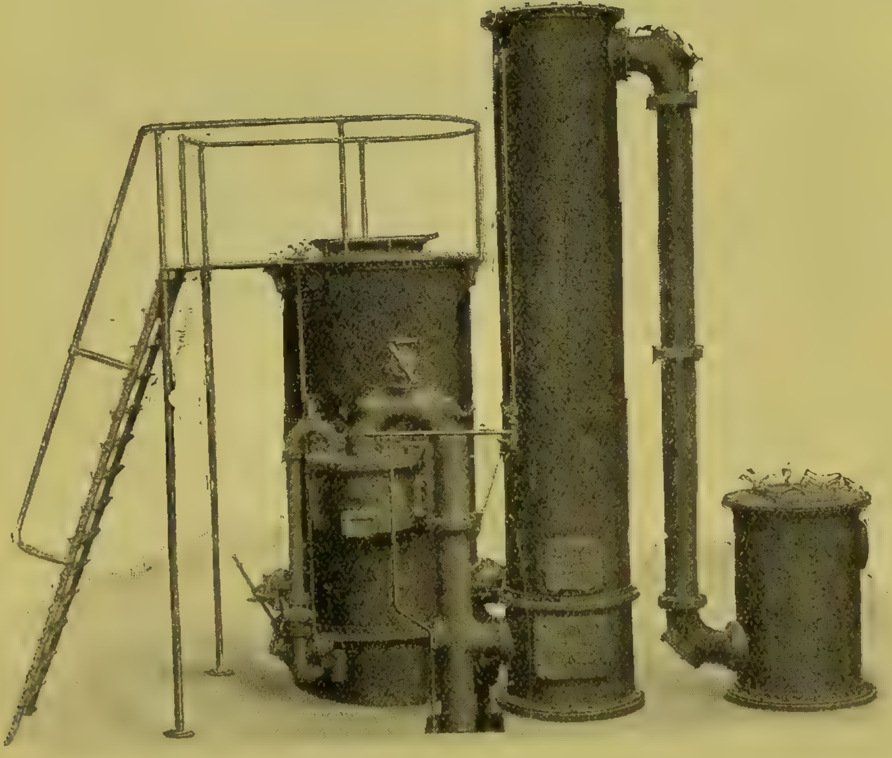

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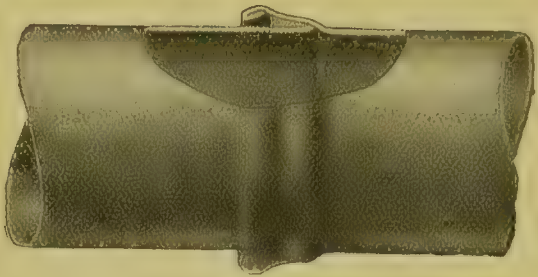

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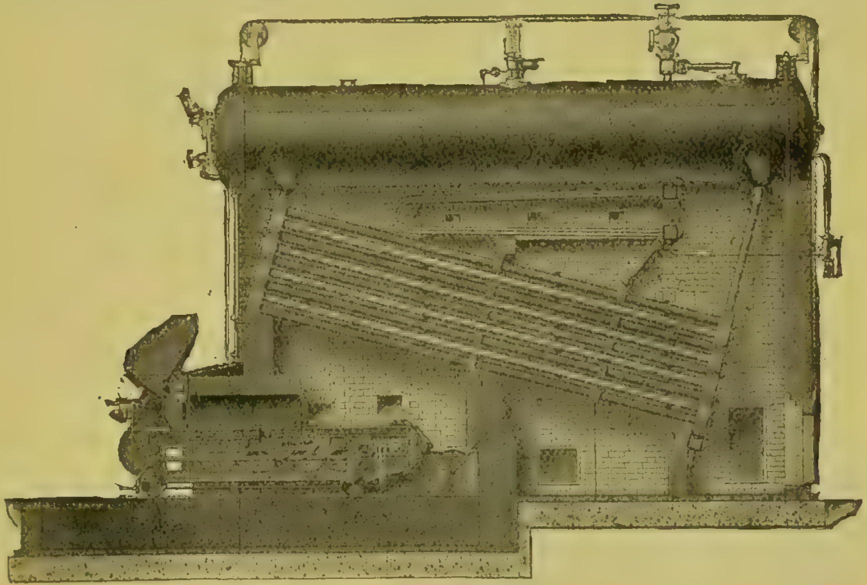

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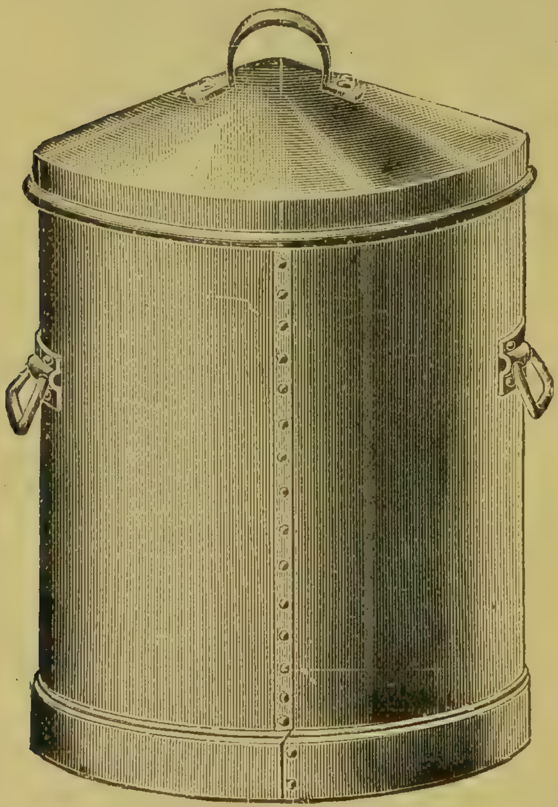

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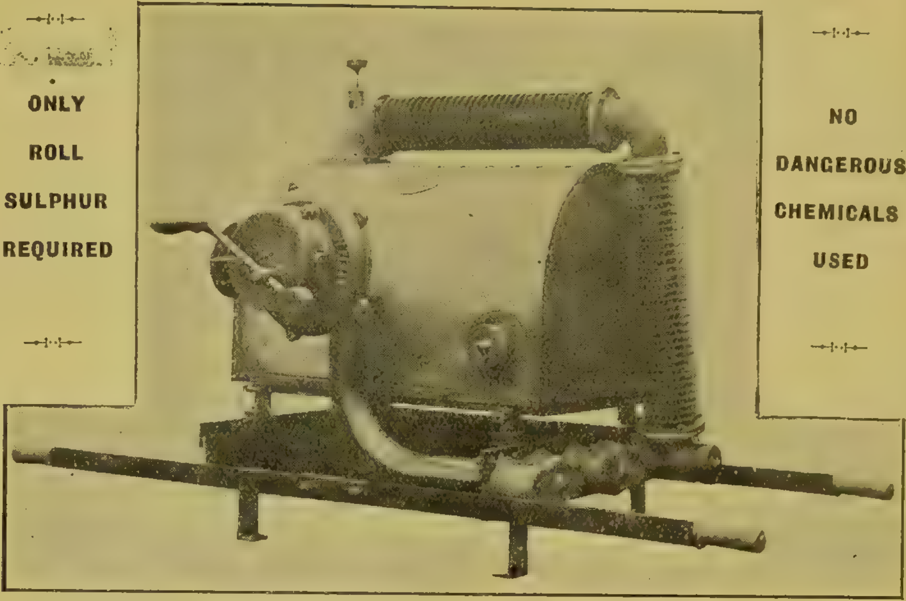

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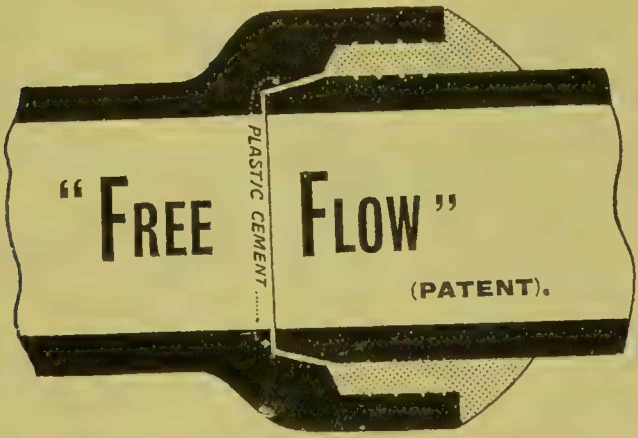

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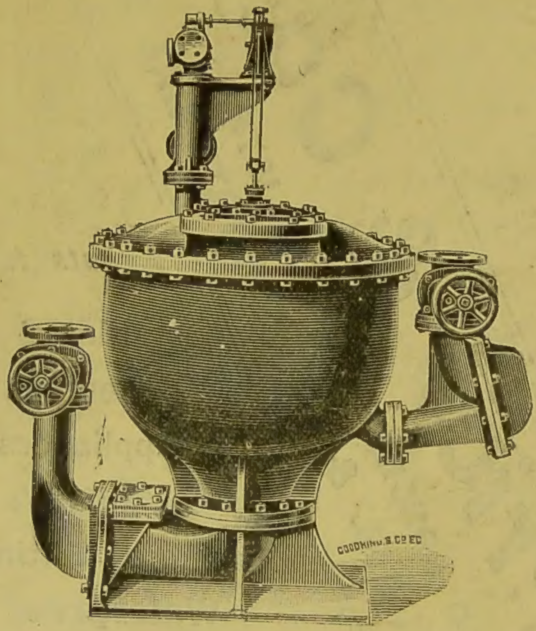

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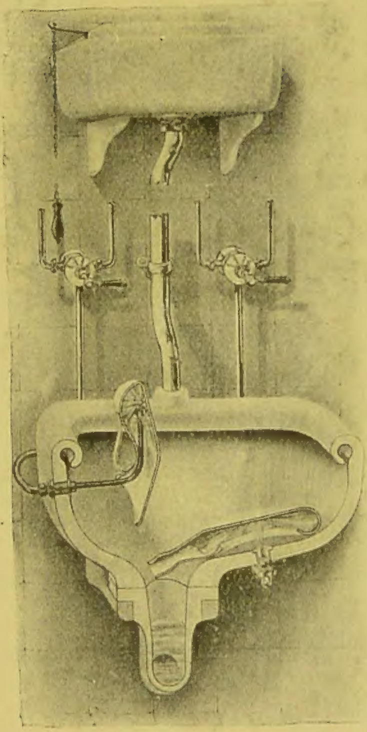

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